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Lee et al.

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(45) **Date of Patent: Oct. 8, 2013**

(54) **WATER CIRCULATION SYSTEM ASSOCIATED WITH REFRIGERANT CYCLE**

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(73) Assignee: **LG Electronics Inc.**, Seoul (KR)

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F25B 7/00 (2006.01)

(52) **U.S. Cl.**
USPC **62/335**

(58) **Field of Classification Search**
USPC 62/278, 335, 510
See application file for complete search history.

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(57) **ABSTRACT**

The present invention proposes a water circulation system associated with a refrigerant cycle that can selectively heat-exchange water for cooling and heating and hot water supplying with at least one of a first refrigerant and a second refrigerant. Therefore, the present invention can improve the operation efficiency of the water circulation system associated with the refrigerant cycle.

20 Claims, 18 Drawing Sheets

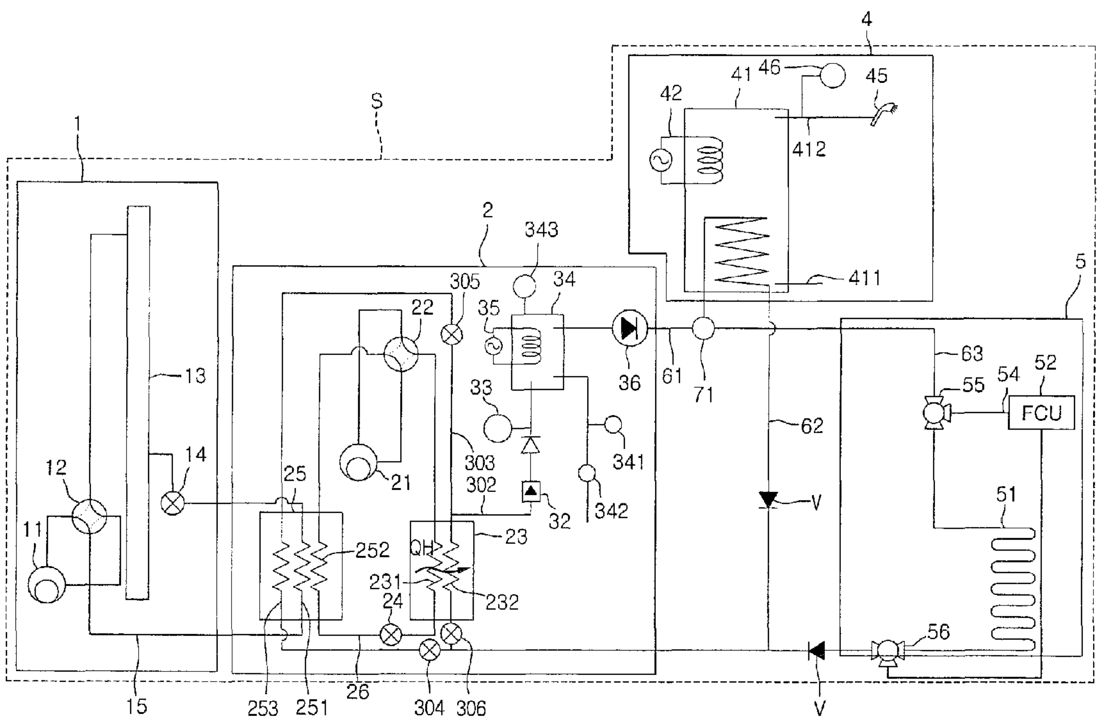


FIG.1

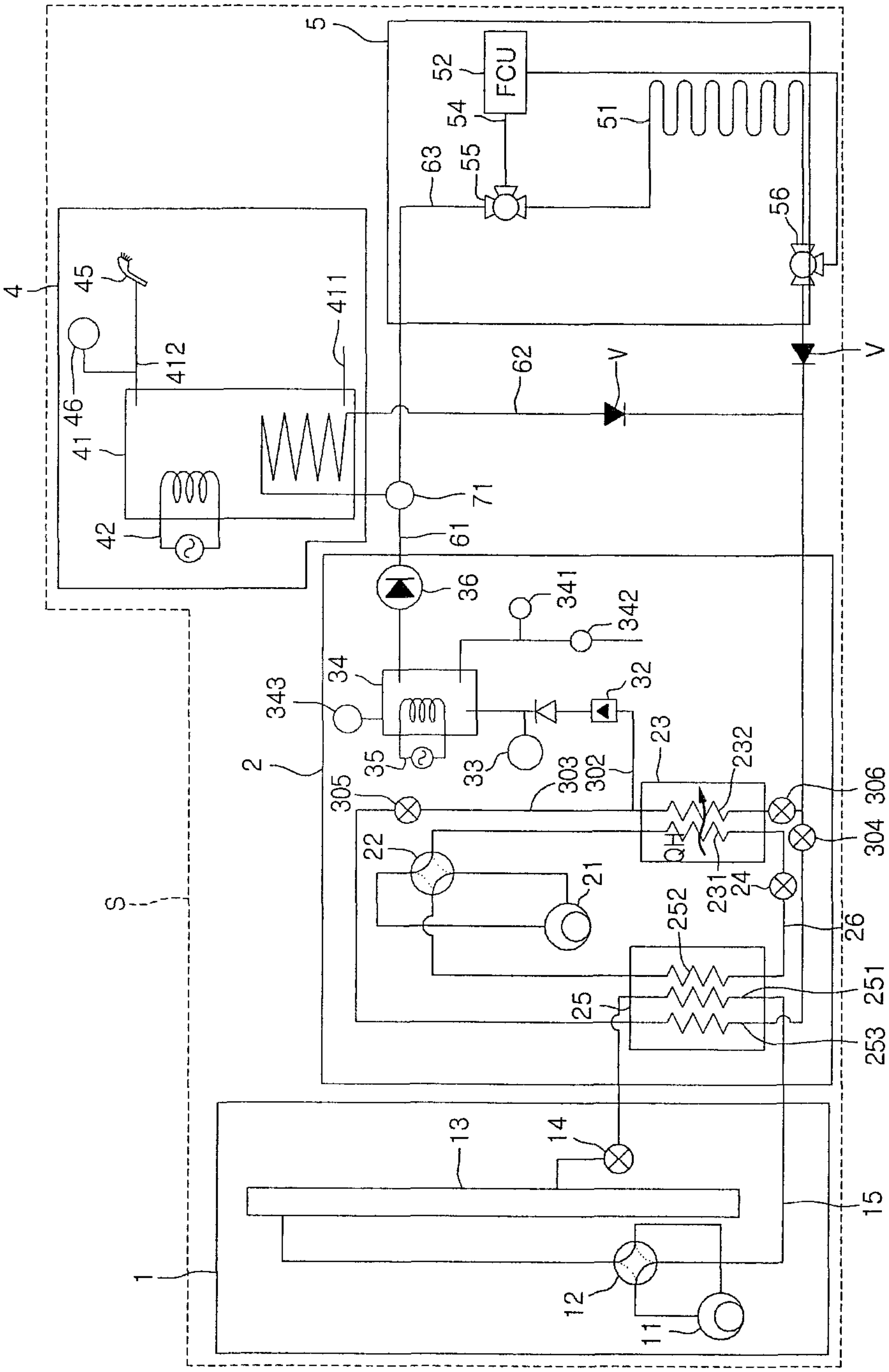

S
1
11
12
13
14
15
2
21
22
23
231
232
24
25
251
252
253
26
302
303
304
305
306
32
33
34
341
342
343
35
36
4
41
411
412
42
45
46
5
51
52
54
55
56
61
62
63
71
V
FCU
QH

FIG.2

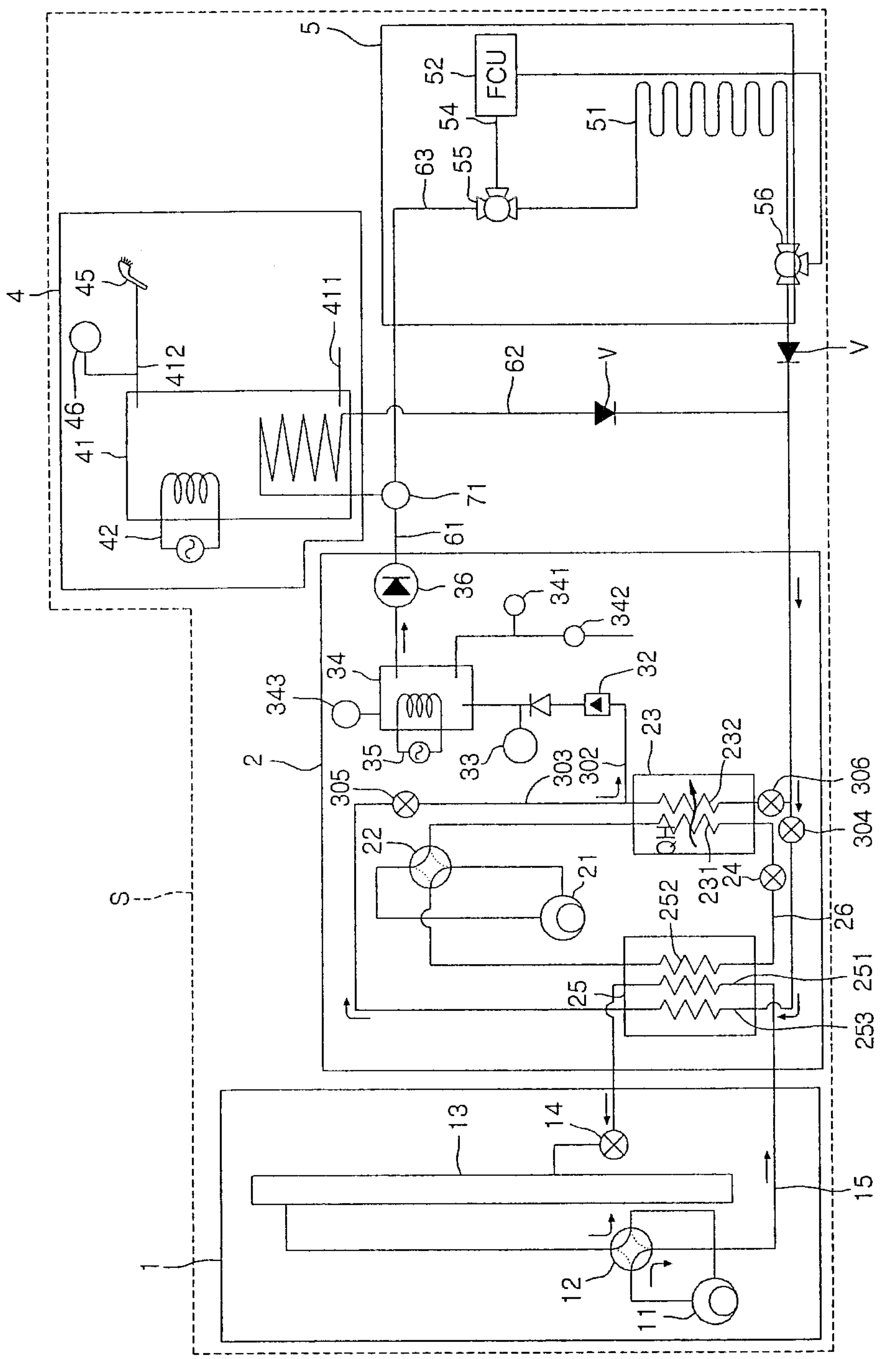
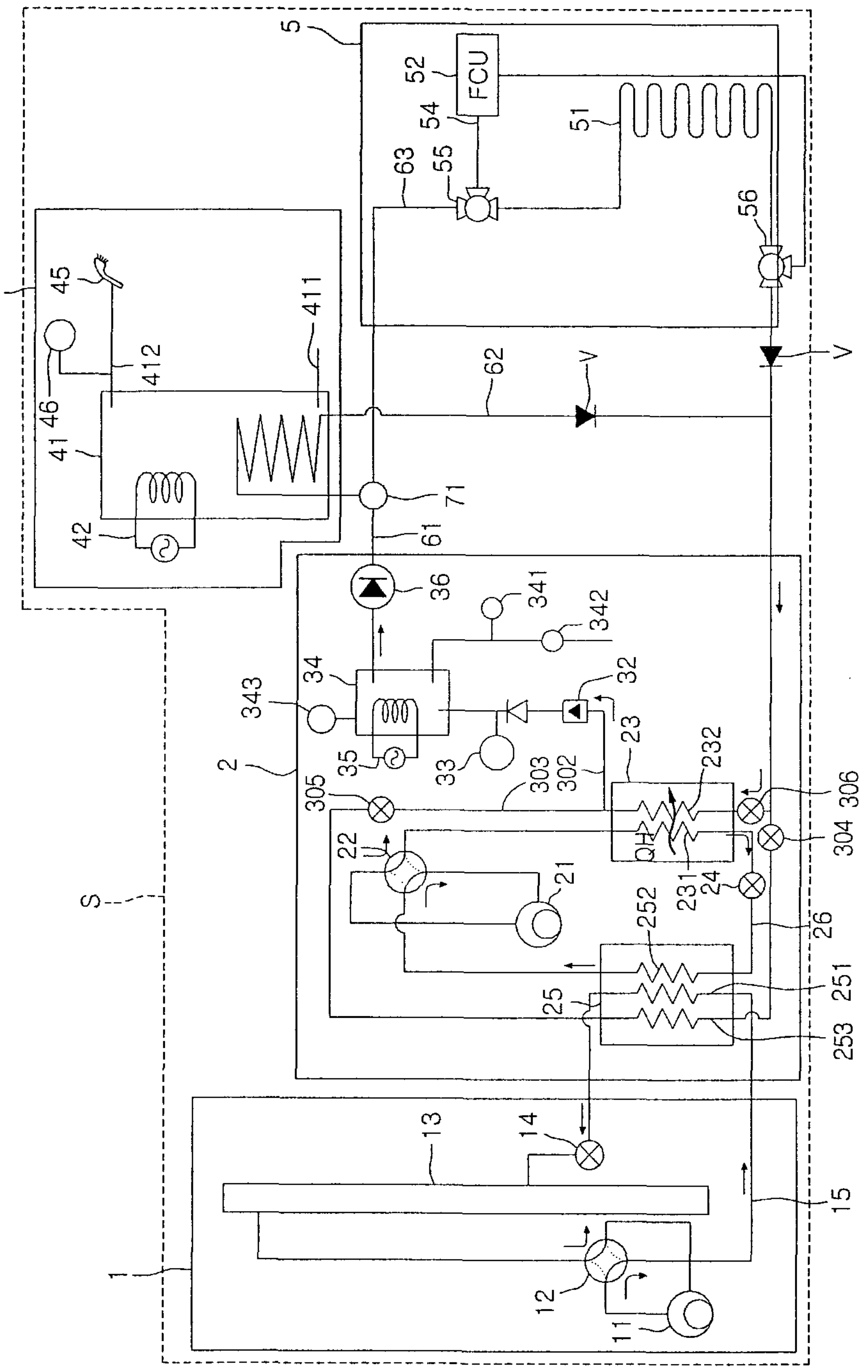

5
52
FCU
54
55
63
51
56
4
45
46
412
411
41
42
62
V
V
71
61
36
341
342
34
343
32
35
33
2
303
302
23
232
305
306
22
304
21
QH
231
24
252
26
25
251
253
S
13
14
15
1
12
11

FIG.3



1
11
12
13
14
15
2
21
22
23
231
232
24
25
251
252
253
26
302
303
304
305
306
32
33
34
341
342
343
35
36
4
41
411
412
42
45
46
5
51
52
FCU
54
55
56
61
62
63
71
V
QH
S

FIG.4

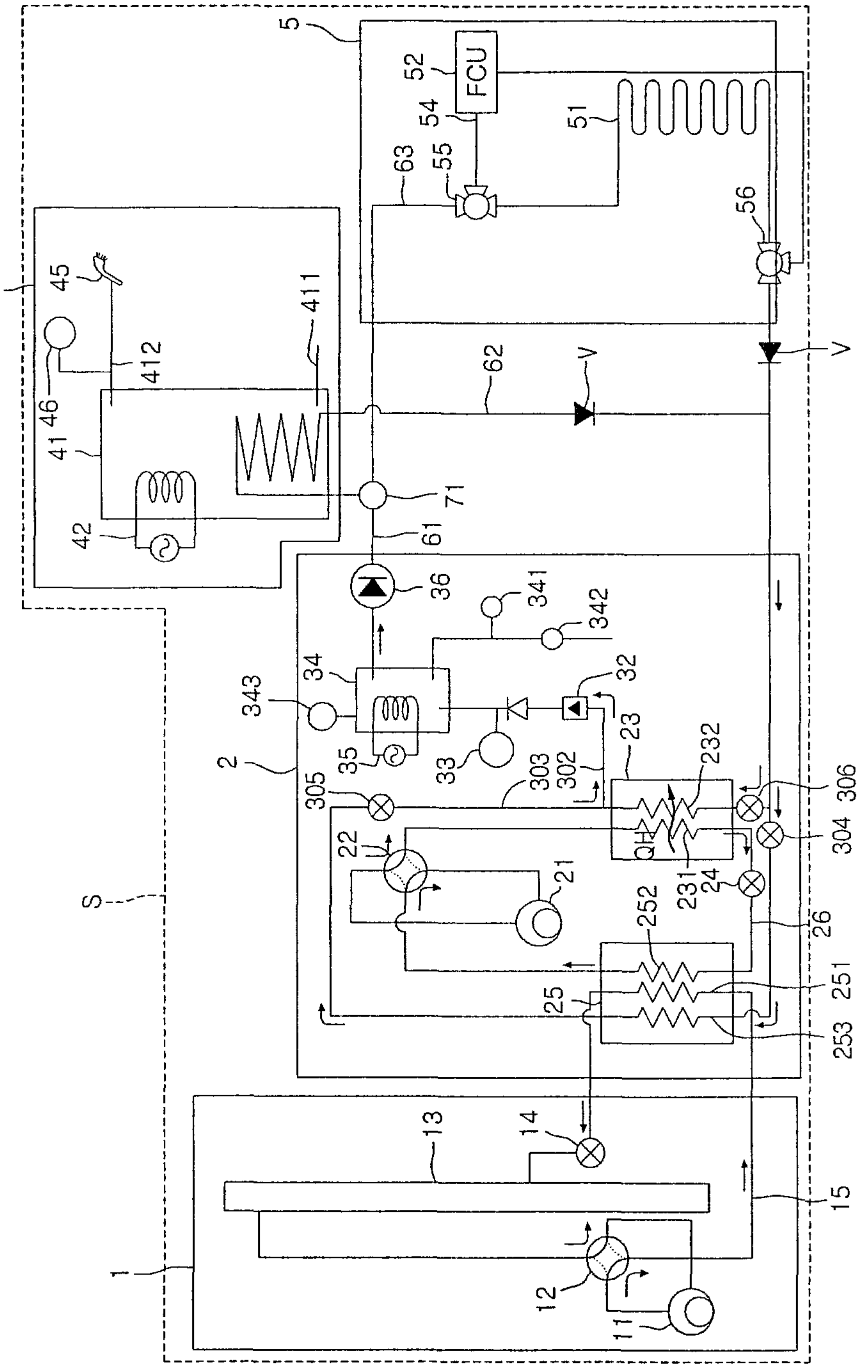

FCU
QH
S
V
1
2
4
5
11
12
13
14
15
21
22
23
24
25
26
32
33
34
35
36
41
42
45
46
51
52
54
55
56
61
62
63
71
231
232
251
252
253
302
303
304
305
306
341
342
343
411
412

FIG.5

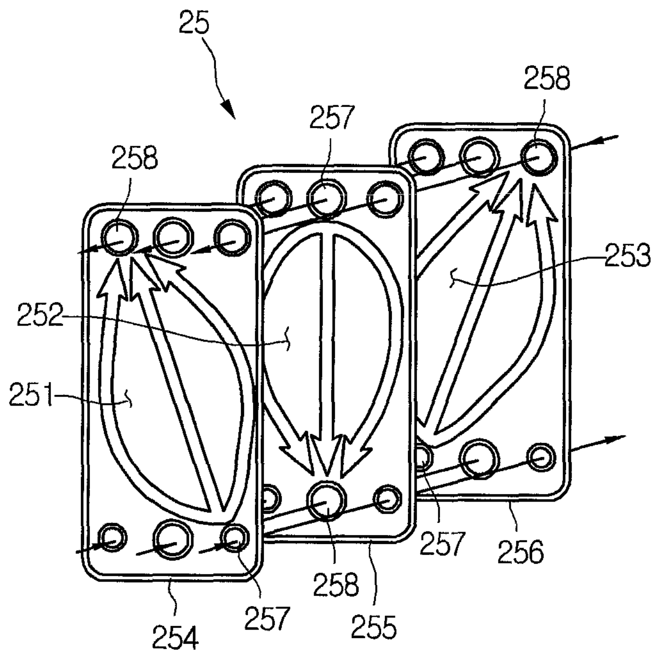


FIG.6

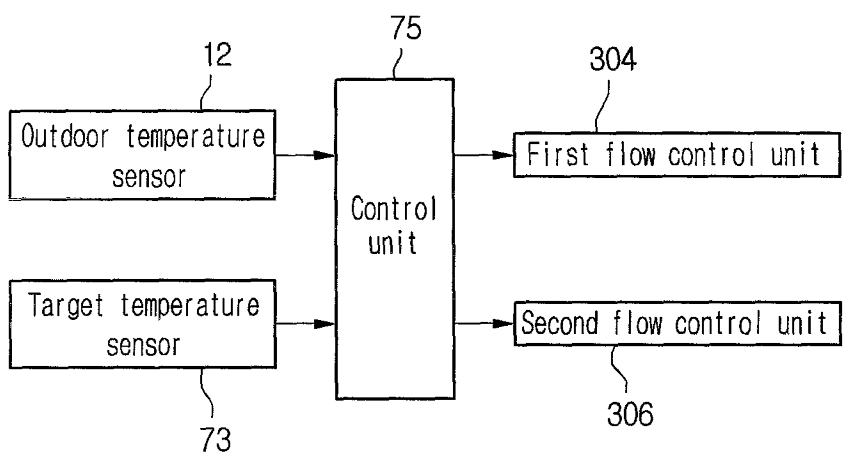

75
12
304
Outdoor temperature sensor
First flow control unit
Control unit
Target temperature sensor
Second flow control unit
306
73

FIG.7

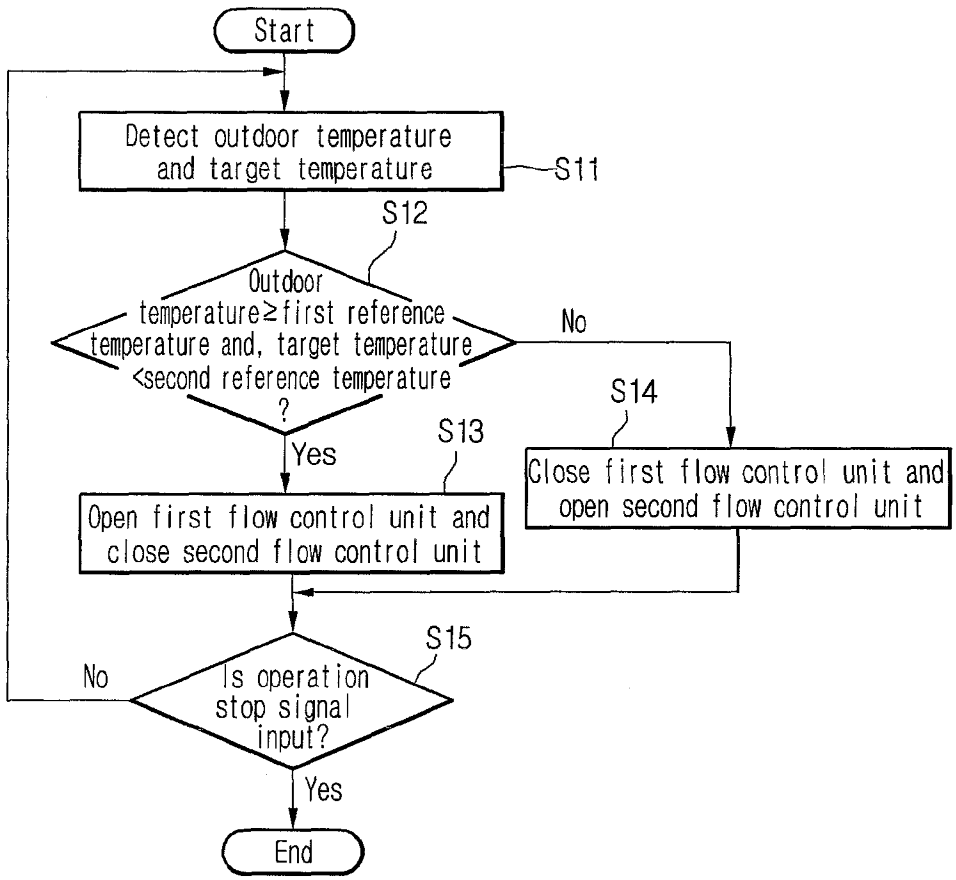

Start
Detect outdoor temperature and target temperature
S11
S12
Outdoor temperature≥first reference temperature and, target temperature <second reference temperature ?
No
Yes
S13
Open first flow control unit and close second flow control unit
S14
Close first flow control unit and open second flow control unit
S15
Is operation stop signal input?
No
Yes
End

FIG.8

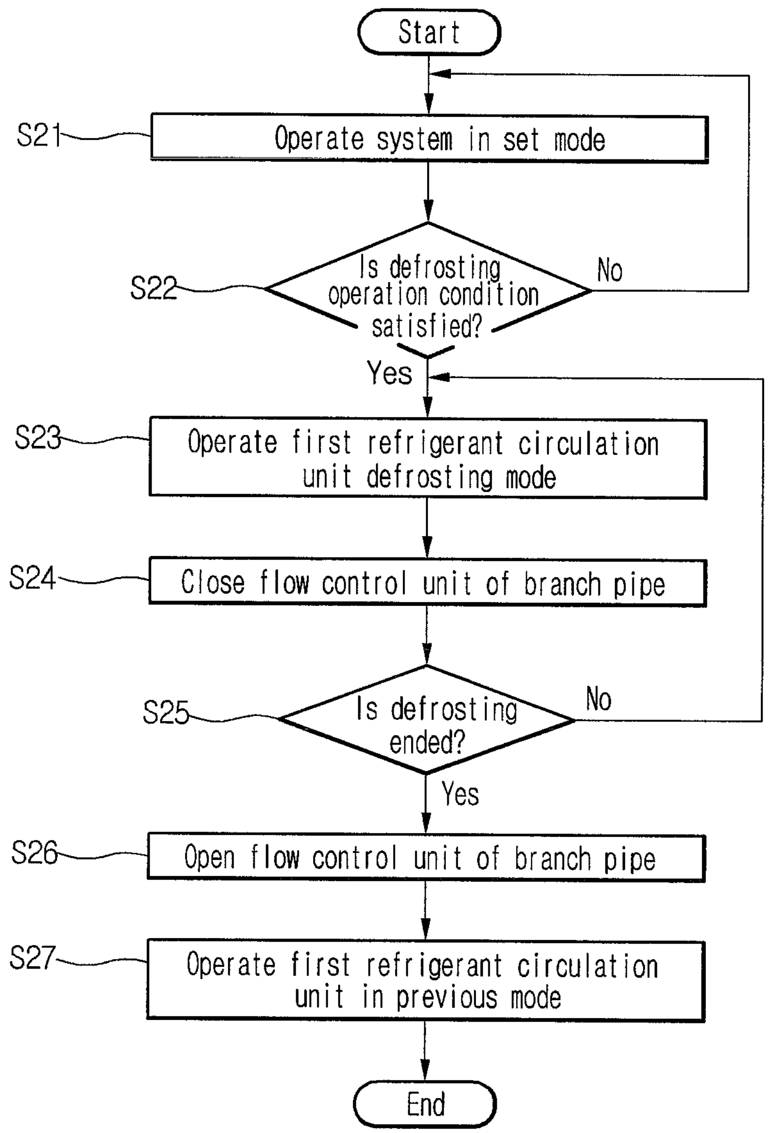
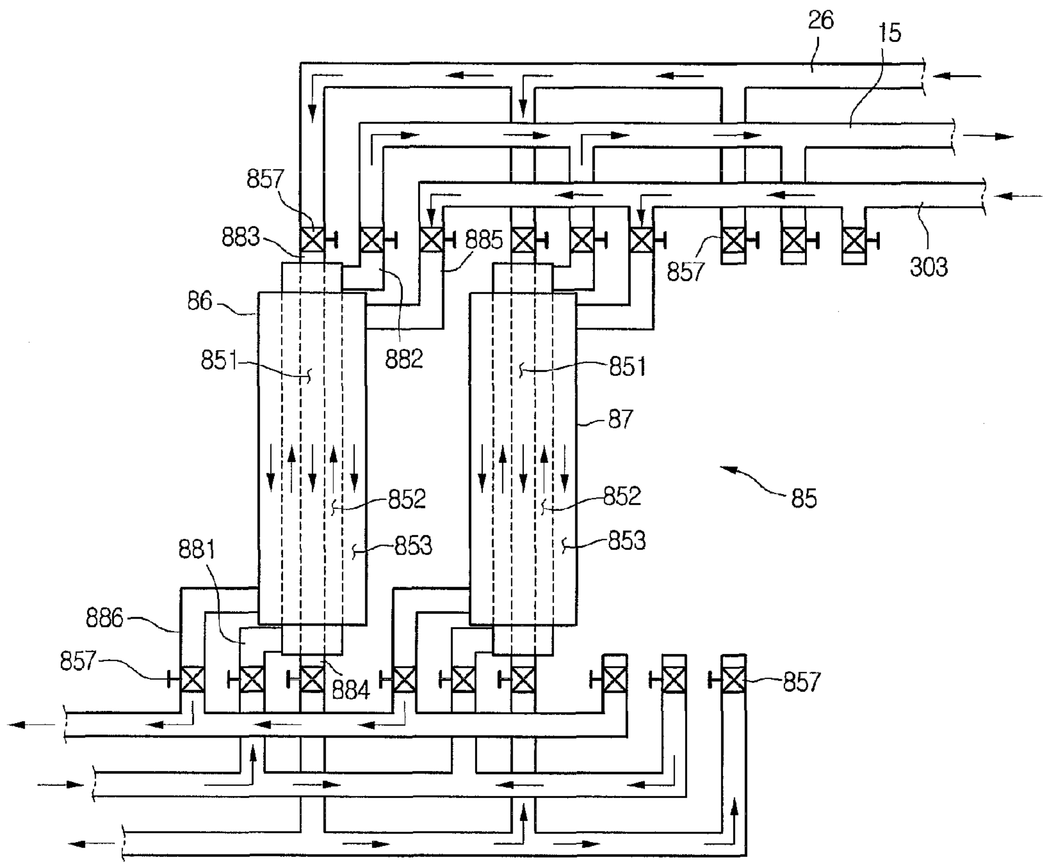

Start
S21
Operate system in set mode
S22
Is defrosting operation condition satisfied?
No
Yes
S23
Operate first refrigerant circulation unit defrosting mode
S24
Close flow control unit of branch pipe
S25
Is defrosting ended?
No
Yes
S26
Open flow control unit of branch pipe
S27
Operate first refrigerant circulation unit in previous mode
End

FIG.9



26
15
857
883
885
857
303
86
882
851
851
87
85
852
852
853
853
881
886
857
884
857

FIG. 10

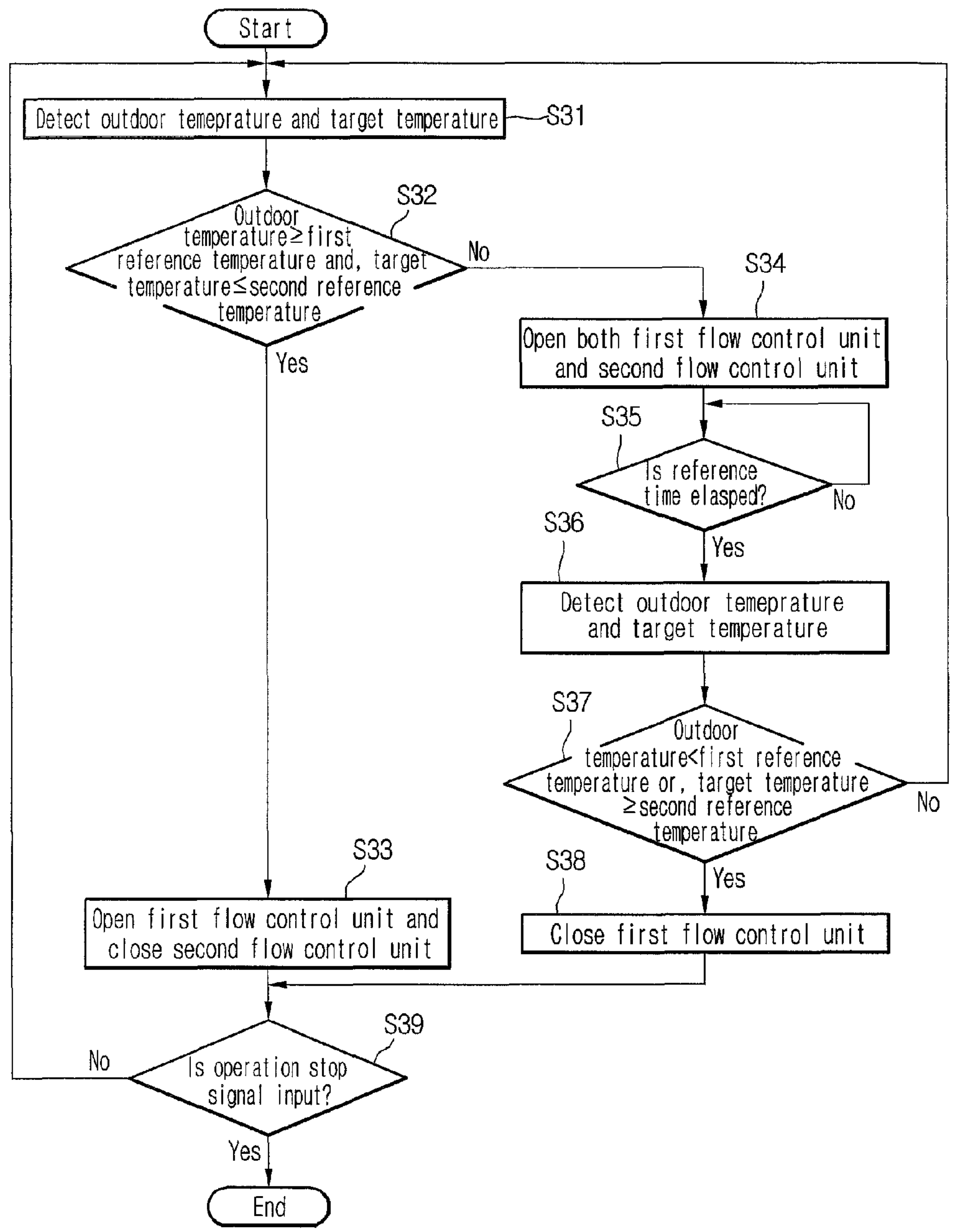

Start
Detect outdoor temeprature and target temperature
S31
S32
Outdoor temperature≥first reference temperature and, target temperature≤second reference temperature
No
Yes
S34
Open both first flow control unit and second flow control unit
S35
Is reference time elasped?
No
Yes
S36
Detect outdoor temeprature and target temperature
S37
Outdoor temperature<first reference temperature or, target temperature ≥second reference temperature
No
Yes
S38
Close first flow control unit
S33
Open first flow control unit and close second flow control unit
S39
Is operation stop signal input?
No
Yes
End

FIG.11

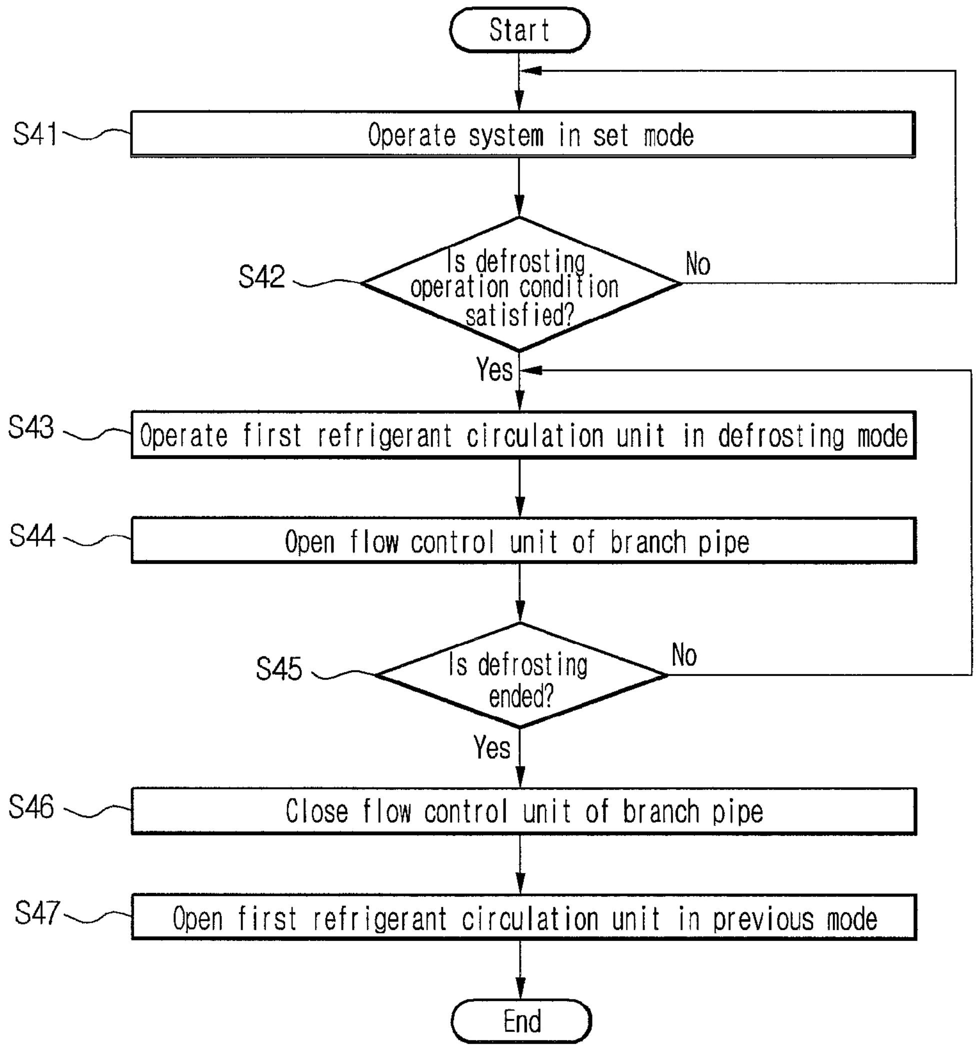

Start
S41
Operate system in set mode
S42
Is defrosting operation condition satisfied?
No
Yes
S43
Operate first refrigerant circulation unit in defrosting mode
S44
Open flow control unit of branch pipe
S45
Is defrosting ended?
No
Yes
S46
Close flow control unit of branch pipe
S47
Open first refrigerant circulation unit in previous mode
End

FIG.12

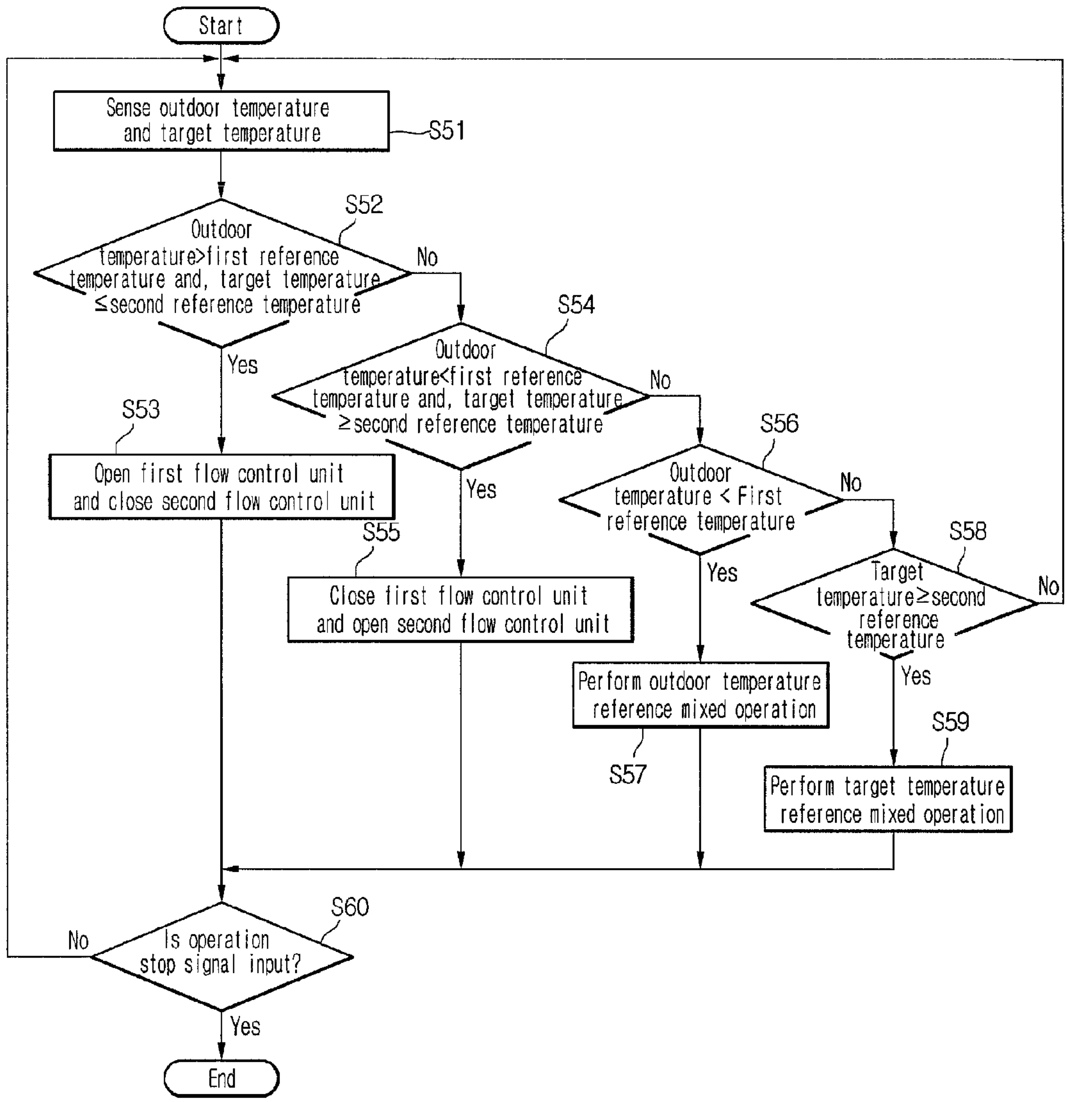

Start
Sense outdoor temperature and target temperature
S51
S52
Outdoor temperature>first reference temperature and, target temperature ≤second reference temperature
No
Yes
S54
Outdoor temperature<first reference temperature and, target temperature ≥second reference temperature
No
Yes
S53
Open first flow control unit and close second flow control unit
S55
Close first flow control unit and open second flow control unit
S56
Outdoor temperature < First reference temperature
No
Yes
S58
Target temperature≥second reference temperature
No
Yes
Perform outdoor temperature reference mixed operation
S57
S59
Perform target temperature reference mixed operation
S60
Is operation stop signal input?
No
Yes
End

FIG. 13

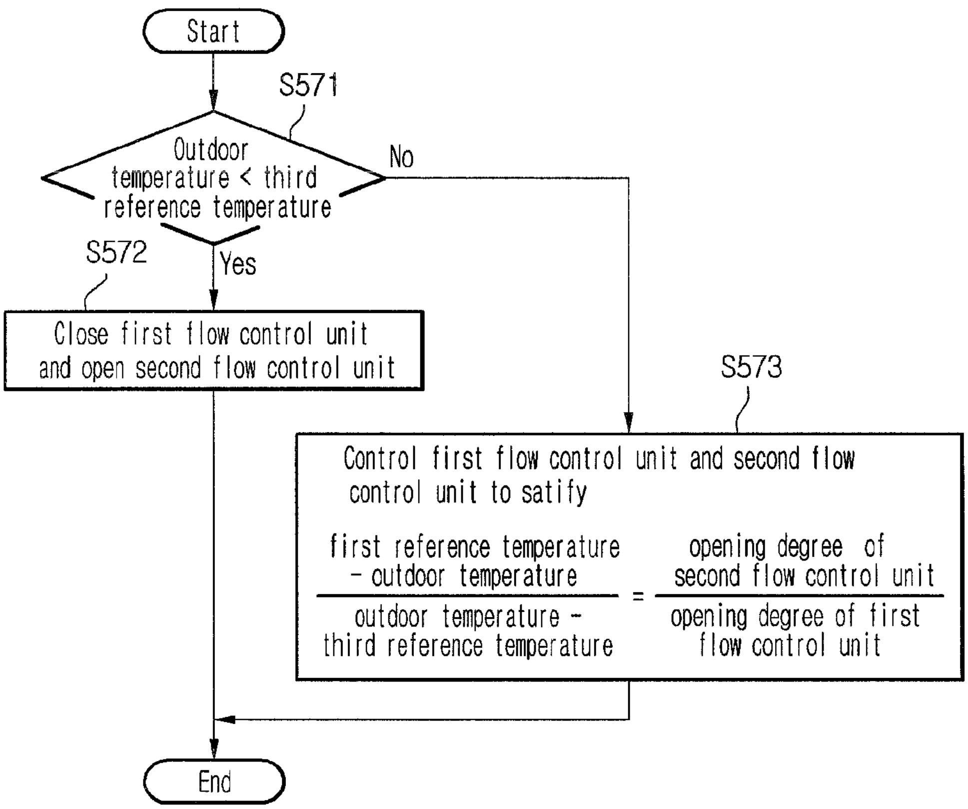

Start
S571
Outdoor temperature < third reference temperature
No
Yes
S572
Close first flow control unit and open second flow control unit
S573
Control first flow control unit and second flow control unit to satify
first reference temperature - outdoor temperature
outdoor temperature - third reference temperature
=
opening degree of second flow control unit
opening degree of first flow control unit
End

FIG.14

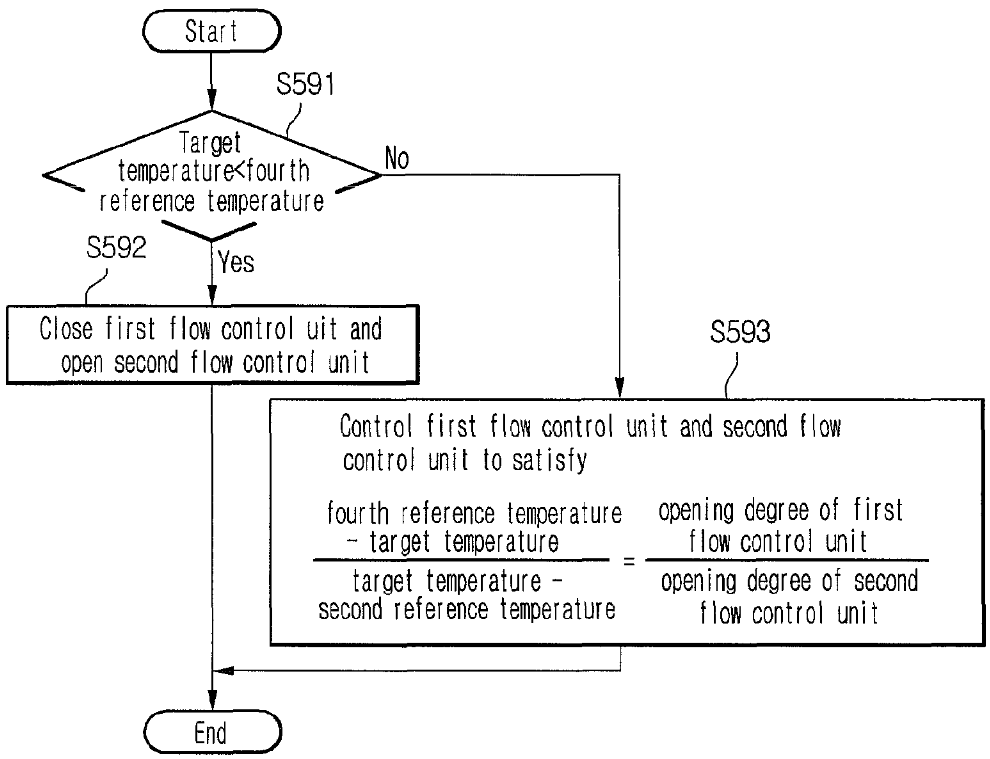

Start
S591
Target temperature<fourth reference temperature
No
S592
Yes
Close first flow control uit and open second flow control unit
S593
Control first flow control unit and second flow control unit to satisfy
fourth reference temperature - target temperature
target temperature - second reference temperature
=
opening degree of first flow control unit
opening degree of second flow control unit
End

FIG.15

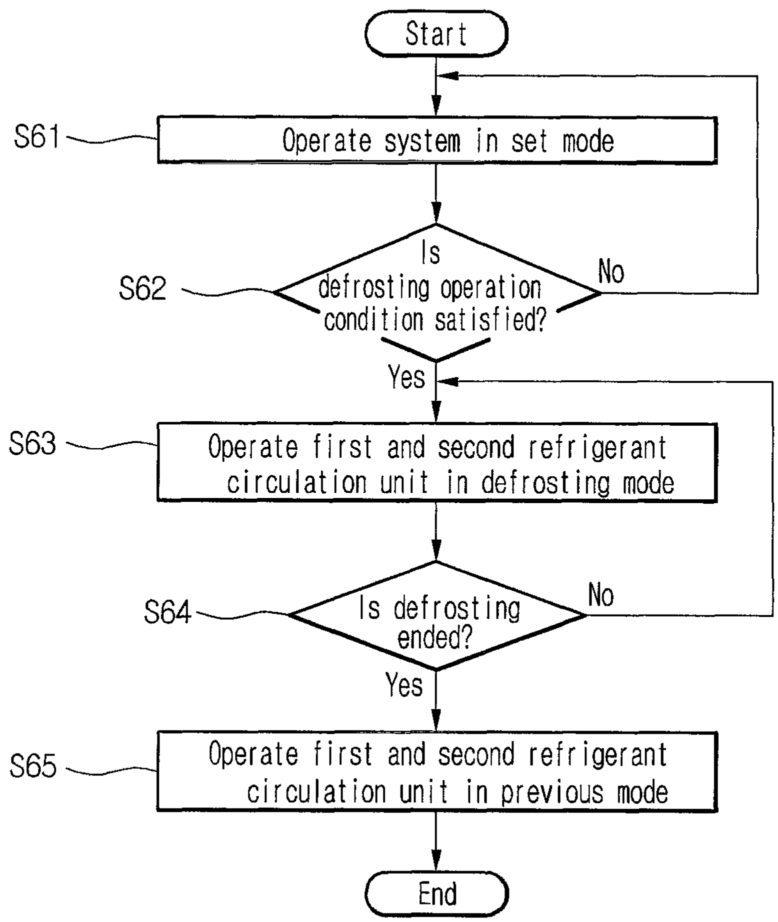

Start
S61
Operate system in set mode
S62
Is defrosting operation condition satisfied?
No
Yes
S63
Operate first and second refrigerant circulation unit in defrosting mode
S64
Is defrosting ended?
No
Yes
S65
Operate first and second refrigerant circulation unit in previous mode
End

FIG.16

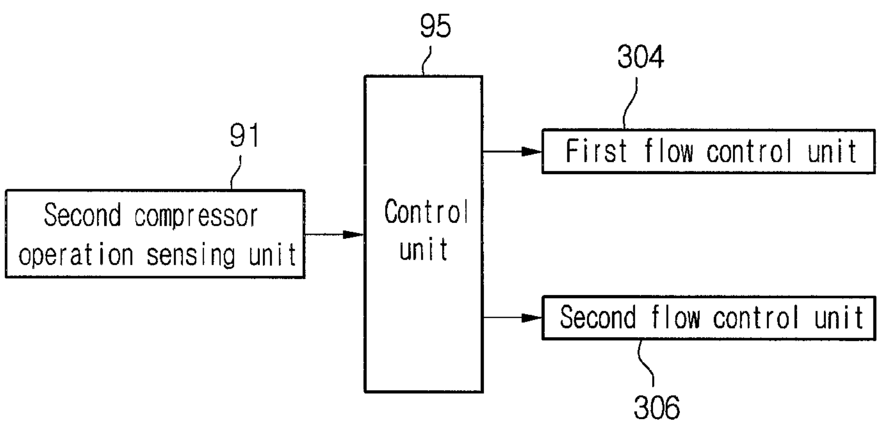

95
304
91
Second compressor operation sensing unit
Control unit
First flow control unit
Second flow control unit
306

FIG.17

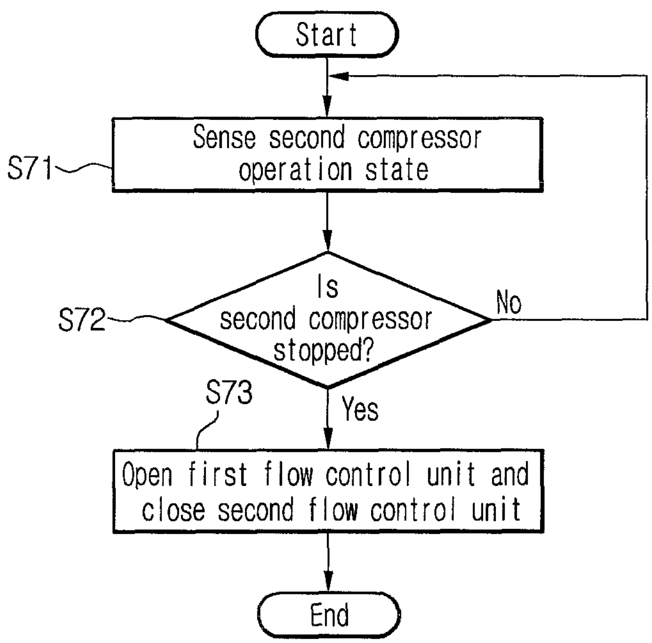
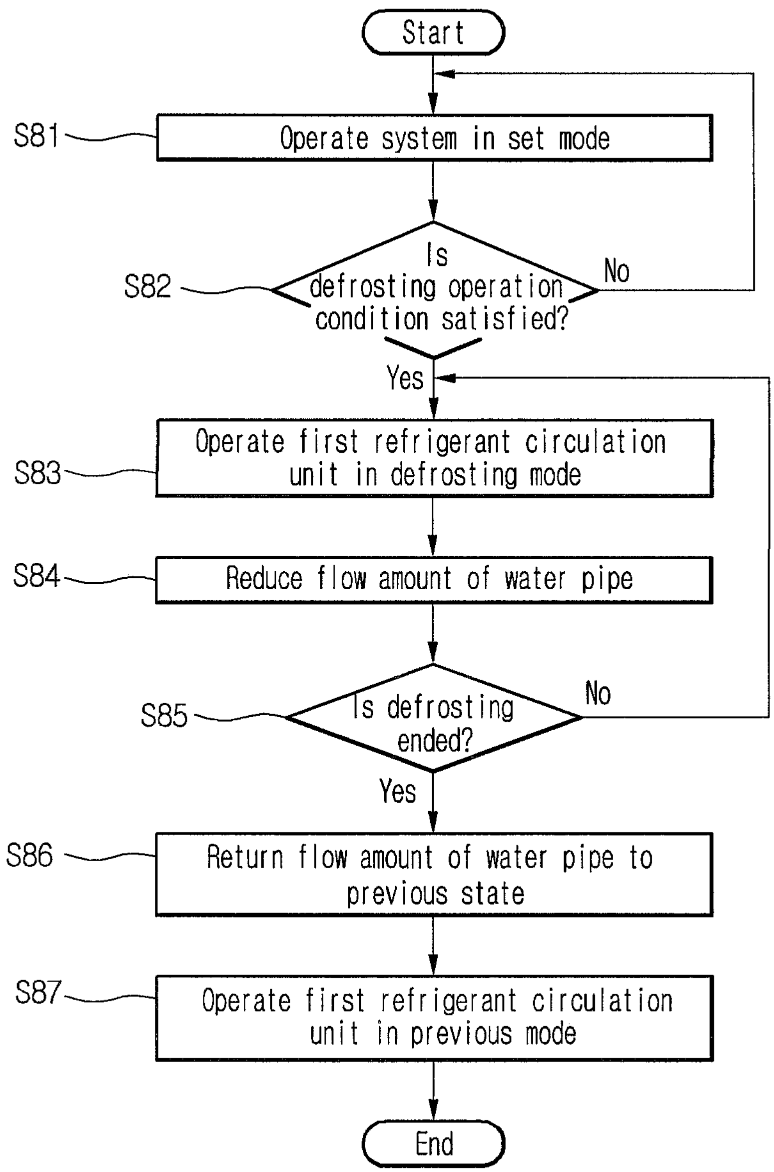

Start
S71
Sense second compressor operation state
S72
Is second compressor stopped?
No
Yes
S73
Open first flow control unit and close second flow control unit
End

FIG. 18


Start
S81
Operate system in set mode
S82
Is defrosting operation condition satisfied?
No
Yes
S83
Operate first refrigerant circulation unit in defrosting mode
S84
Reduce flow amount of water pipe
S85
Is defrosting ended?
No
Yes
S86
Return flow amount of water pipe to previous state
S87
Operate first refrigerant circulation unit in previous mode
End

WATER CIRCULATION SYSTEM ASSOCIATED WITH REFRIGERANT CYCLE

BACKGROUND OF THE INVENTION

1. Field of the Invention

The present invention relates to an indoor unit of a water circulation system performing a hot water supplying function and cooling and heating functions in association with a refrigerant cycle.

2. Description of the Related Art

In the related art, indoor cooling and heating are performed by an air conditioner using the refrigerant cycle and supplying hot water is performed by a boiler with an additional heating source.

More specifically, the air conditioner includes an outdoor unit installed in an outdoor area and an indoor unit installed in an indoor area. The outdoor unit includes a compressor compressing refrigerant, an outdoor heat exchanger for exchanging heat of outdoor air with the refrigerant, and a decompressing device and the indoor unit includes an indoor heat exchanger for exchanging heat of indoor air with the refrigerant. At this time, any one of the outdoor heat exchanger and the indoor heat exchanger serves as a condenser and the other one serves as an evaporator and the compressor, the outdoor heat exchanger, the decompressing device, and the indoor heat exchanger perform a refrigerant cycle.

In addition, the boiler generates heat by using oil, gas, or electricity and heats water to supply hot water or perform floor heating.

SUMMARY OF THE INVENTION

The present invention provides a water circulation system associated with a refrigerant cycle that can selectively heat exchange water for cooling and heating and hot water supplying with at least one of a first refrigerant and a second refrigerant. The water circulation system associated with the a refrigerant cycle according to the present invention includes: a first refrigerant circulation unit where a first refrigerant exchanging heat with outdoor air flows to perform the refrigerant cycle; a second refrigerant circulation unit where a second refrigerant exchanging heat with the first refrigerant flows to perform the refrigerant cycle; a water circulation unit where water for at least one of indoor heating/cooling and hot water supplying flows; a first water heat exchanger where the heat exchange between the first refrigerant and water is performed; a second water heat exchanger where the heat exchange between the second refrigerant and water is performed; a first flow control unit that selectively prevents the flow of water to the first water refrigerant heat exchanger; and a second flow control unit that selectively prevents the flow of water to the second water refrigerant heat exchanger. Therefore, the present invention can improve the operation efficiency of the water circulation system associated with the refrigerant cycle.

BRIEF DESCRIPTION OF THE DRAWINGS

FIG. **1** is a configuration diagram of a first embodiment of a water circulation system associated with a refrigerant cycle according to the present invention;

FIG. **2** is a diagram showing the flow of refrigerant when a first embodiment of a water circulation system associated with a refrigerant cycle according to the present invention is operated in one-stage compression type;

FIG. **3** is a diagram showing the flow of refrigerant when a first embodiment of a water circulation system associated with a refrigerant cycle according to the present invention is operated in two-stage compression type;

FIG. **4** is a diagram showing the flow of refrigerant when a first embodiment of a water circulation system associated with a refrigerant cycle according to the present invention is operated in one-stage and two-stage mixed compression type;

FIG. **5** is a diagram showing the shape of an intermediate heat exchanger in a first embodiment of a water circulation system associated with a refrigerant cycle according to the present invention;

FIG. **6** is a control configuration diagram of a first embodiment of a water circulation system associated with a refrigerant cycle according to the present invention;

FIG. **7** is a flowchart showing a control flow when the first embodiment of the water circulation system associated with the refrigerant cycle according to the present invention performs a heating operation;

FIG. **8** is a flowchart showing a control flow when the first embodiment of the water circulation system associated with the refrigerant cycle according to the present invention performs a defrosting operation;

FIG. **9** is a diagram showing the shape of an intermediate heat exchanger in a second embodiment of a water circulation system associated with a refrigerant cycle according to the present invention;

FIG. **10** is a flowchart showing a control flow when the second embodiment of the water circulation system associated with the refrigerant cycle according to the present invention performs a heating operation;

FIG. **11** is a flowchart showing a control flow when the second embodiment of the water circulation system associated with the refrigerant cycle according to the present invention performs a defrosting operation;

FIG. **12** is a flowchart showing a control flow when a third embodiment of a water circulation system associated with a refrigerant cycle according to the present invention performs a heating operation;

FIG. **13** is a flowchart showing a mixed operation process based on an outdoor temperature in the third embodiment of the water circulation system associated with the refrigerant cycle according to the present invention;

FIG. **14** is a flowchart showing a mixed operation process based on a target temperature in the third embodiment of the water circulation system associated with the refrigerant cycle according to the present invention;

FIG. **15** is a flowchart showing a control flow when the third embodiment of the water circulation system associated with the refrigerant cycle according to the present invention performs a defrosting operation;

FIG. **16** is a control configuration diagram of a fourth embodiment of a water circulation system associated with a refrigerant cycle according to the present invention;

FIG. **17** is a flowchart showing a control flow when the fourth embodiment of the water circulation system associated with the refrigerant cycle according to the present invention performs a heating operation; and

FIG. **18** is a flowchart showing a control flow when the fourth embodiment of the water circulation system associated with the refrigerant cycle according to the present invention performs a defrosting operation.

DETAILED DESCRIPTION OF THE EMBODIMENTS

Reference will now be made in detail to the embodiments of the present disclosure, examples of which are illustrated in the accompanying drawings.

In the following detailed description of the preferred embodiments, reference is made to the accompanying drawings that form a part hereof, and in which is shown by way of illustration specific preferred embodiments in which the invention may be practiced. These embodiments are described in sufficient detail to enable those skilled in the art to practice the invention, and it is understood that other embodiments may be utilized and that logical structural, mechanical, electrical, and chemical changes may be made without departing from the spirit or scope of the invention. To avoid detail not necessary to enable those skilled in the art to practice the invention, the description may omit certain information known to those skilled in the art. The following detailed description is, therefore, not to be taken in a limiting sense, and the scope of the present invention is defined only by the appended claims.

FIG. **1** is a configuration diagram of a first embodiment of a water circulation system associated with a refrigerant cycle according to the present invention.

Referring to FIG. **1**, the water circulation system S associated with the refrigerant cycle includes a first refrigerant circulation unit where first refrigerant exchanging heat with outdoor air flows to perform the refrigerant cycle, a second refrigerant circulation unit where second refrigerant exchanging heat with the first refrigerant flows to perform the refrigerant cycle, and a water circulation unit where water for at least one of indoor heating/cooling and hot water supplying. At this time, the refrigerant cycle means transmitting the heat by repetitively performing compression, condensation, expansion, and evaporation processes.

In addition, the water circulation system S associated with the refrigerant cycle includes an outdoor unit **1** where an outdoor heat exchanger **13** exchanging the first refrigerant and the outdoor air with each other is installed and an intermediator **2** that intermediates the outdoor **1** with the water circulation unit and includes a water refrigerant heat exchanger **23** exchanging heat between the second refrigerant and water.

Specifically, the first refrigerant circulation unit includes the outdoor heat exchanger **13**, a first compressor **11** compressing the first refrigerant, a first expansion unit **14** expanding the first refrigerant, a first flow switch **12** switching a flow direction of the first refrigerant, an intermediate heat exchanger **25** exchanging heat between the first refrigerant and the second refrigerant, and a first refrigerant pipe **15**. That is, the first refrigerant performs the refrigerant cycle while sequentially circulating any one of the first compressor **11**, the outdoor heat exchanger **13**, and the intermediate heat exchanger **25** and the other one of the first expansion unit **14**, the outdoor heat exchanger **13**, and the intermediate heat exchanger. Further, by the first flow switch **12**, the flow direction of the first refrigerant may be switched into a direction in which the first refrigerant is introduced into the outdoor heat exchanger **13** from the intermediate heat exchanger **25** through the first expansion unit **14** or a reverse direction.

In addition, the second refrigerant circulation unit includes the intermediate heat exchanger **25**, a second compressor **21** compressing the second refrigerant, a second expansion unit **24** expanding the second refrigerant, a second flow switch **22** switching a flow direction of the second refrigerant, the water refrigerant heat exchanger **23**, and a second refrigerant pipe **26**. That is, the second refrigerant performs the refrigerant cycle while sequentially circulating any one of the second compressor **21**, the intermediate heat exchanger **25**, and the water refrigerant heat exchanger **23** and the other one of the second expansion unit **24**, the intermediate heat exchanger **25**, and the water refrigerant heat exchanger **23**. Further, by the second flow switch **22**, the flow direction of the second refrigerant may be switched into a direction in which the second refrigerant is introduced into the intermediate heat exchanger **25** from the water refrigerant heat exchanger **23** through the second expansion unit **24** or a reverse direction.

At this time, the intermediate heat exchanger **25** through which the first referent, second refrigerant, and water pass at the same time is included in the first refrigerant circulation unit or included in the second refrigerant circulation unit. In addition, in the intermediate heat exchanger **25**, three flow passages **251**, **252**, and **253** for allowing the first refrigerant, second refrigerant, and water to flow, respectively are formed. Accordingly, in the intermediate heat exchanger **25**, the first refrigerant, second refrigerant, and water exchange heat with each other at the same time. That is, the intermediate heat exchanger **25** serves as the water refrigerant heat exchanger where the heat is exchanged between the water and the water in a functional sense.

In another aspect, the intermediate heat exchanger **25** may serve as a first water refrigerant heat exchanger where the heat is exchanged between the first refrigerant and the water and the water refrigerant heat exchanger **23** may serve as a second water refrigerant heat exchanger where the heat is exchanged between the second refrigerant and the water.

Meanwhile, the outdoor heat exchanger **13**, the first compressor **11**, the first expansion unit **14**, and the first flow switch **12** are installed in the outdoor unit **1**. In the case where the outdoor unit **1** is operated in a cooling mode, the outdoor heat exchanger **13** serves as the condenser and serves as the evaporator in the case where the outdoor unit **1** is operated in a heating mode.

In addition, the intermediate heat exchanger **25**, the water refrigerant heat exchanger **23**, the second compressor **21**, and the second flow switch **22** are installed in the intermediator **2**. Moreover, in the intermediator **2**, the water refrigerant heat exchanger **23**, a flow switch **32** that is mounted on a water pipe **61** extending to the outlet of the water refrigerant heat exchanger **23** and senses the flow of the water, an expansion tank **33** branched from any point separated from the flow switch **32** in the flow direction of the water, a water collection tank **34** into which the end of the water pipe **61** extending from the outlet of the water refrigerant heat exchanger **23** is inserted and which an auxiliary heat **35** is provided, and a water pump **36** provided at any point of the water pipe **61** of the outlet side of the water collection tank **34**.

More specifically, the water refrigerant heat exchanger **23** may adopt, for example, a plate-type heat exchanger as a device where the heat is exchanged between refrigerant that flows on a closed circuit of the refrigerant cycle and water that flows on the water pipe **61**. At least two flow passages **231** and **232** where the refrigerant and the water independently flow and exchange the heat are formed in the water refrigerant heat exchanger **23**.

Further, when the volume of water heated while passing through the water refrigerant heat exchanger **23** is expanded at an appropriate level or more, the expansion tank **33** performs an absorption function to absorb the expansion.

Further, the water collection tank **34** is a container where the water passing through the water refrigerant heat exchanger **23** is collected. In addition, the auxiliary heat **35** is mounted in the water collection tank **34**, such that the auxiliary heat **35** is selected operated in the case where a heat quantity transferred through the water refrigerant heat exchanger **23** does not reach a required heat quality like a case where a defrosting operation is performed.

In addition, an air vent **343** is formed on the top of the water collection tank **34** to discharge air of an overheat state that exists in the water collection tank **34**. Moreover, a pressure gauge **341** and a relief valve **342** are provide at one portion of the water collection tank **34**, such that the internal pressure of the water collection tank **34** may appropriately be controlled. For example, when the internal water pressure of the water collection tank **34** displayed through the pressure gauge **341** is excessively high, the relief valve **342** is opened to appropriately control the internal pressure of the tank.

Further, the water pump **36** pumps water discharged through the water pip **61** extending from the outlet of the water collection tank **34** to supply it to a hot water supplying unit **4** and a cooling/heating unit **5**.

Meanwhile, the water circulation unit includes the hot water supplying unit **4** where water for supplying hot water, that is, hot water supplying flows and the cooling/heating unit **5** where water for indoor cooling and heating flows.

More specifically, the hot water supplying unit **4** is a part heating and supplying water required for an operation such as user's washing or dish-washing. Specifically, a three-way valve **71** controlling the flow of the water is provided at any point separated from the water pump **36** in the flow direction of the water. The three-way valve **71** is a direction change valve that allows the water pumped by the water pump **36** to flow to the hot water supplying unit **4** or the cooling/heating unit **5**. Accordingly, each of a hot water supplying pipe **62** extending to the hot water supplying unit **4** and the cooling/heating pipe **63** extending to the cooling/heating unit **5** are connected to the outlet of the three-way valve **71**. In addition, the water pumped by the water pump **36** selectively flows to any one of the hot water supplying pipe **62** or the cooling/heating pipe **63** by the control of the three-way valve **71**.

A hot water supplying tank **41** that stores water supplied from the outside and heats the stored water and an auxiliary heat **42** that is provided in the hot water supplying tank **41** are included in the hot water supplying unit **4**. In addition, a water introduction portion **411** for introducing cooling water and a water discharge portion **412** for discharging heated water are provided on one side of the hot water supplying unit.

Specifically, a part of the hot water supplying pipe **62** extending from the three-way valve **71** is inputted into the hot water supplying tank **41** and heats the water stored in the hot water supplying tank **41**. That is, heat is transmitted from high-temperature water that flows along the inside of the hot water supplying pipe **62** to the water stored in the hot water supplying tank **41**. In addition, in a predetermined case, the auxiliary heat **35** and the auxiliary heat source operate to further supply additional heat. For example, like a case where the user needs a lot of water to take a bath, they may operate when the water needs to be heated within a short time. According to the embodiment, a water discharge device such as a shower or a home appliance device such as a humidifier may be connected to the water discharge unit **412**.

Meanwhile, the cooling/heating unit **5** includes a floor cooling/heating unit **51** formed by burying a part of the cooling/heating pipe **63** in an indoor floor and an air cooling/heating unit **52** that is branched from any one point of the cooling/heating pipe **63** and in parallel, connected with the floor cooling/heating unit **51**.

Specifically, the floor cooling/heating unit **51** may be buried in the indoor floor in the form of a meander line as shown in the figure. Further, the air cooling/heating unit **52** may be a fan coil unit or a radiator, etc. Further, in the air cooling/heating unit **52**, a part of the air cooling/heating pipe **54** branched from the cooling/heating pipe **63** is provided as a heat exchange means. Moreover, a flow passage switching valve **56** such as the three-way valve **71** is installed at a point where the air cooling/heating pipe is branched and refrigerant that flows on the cooling/heating pipe **63** flows by being divided into the floor cooling/heating unit **51** and the air cooling/heating unit **52** or flows to only any one of the floor cooling/heating unit **51** and the air cooling/heating unit **52**.

Further, an end portion of the hot water supplying pipe **62** extending from the three-way valve **71** is united at a point separated from an outlet of the air cooling/heating pipe **54** in the flow direction of the water. Therefore, in a hot water supplying mode, the refrigerant that flows on the hot water supplying pipe **62** is combined into the cooling/heating pipe again and thereafter, is introduced into the water refrigerant heat exchanger **23**.

Herein, like a point where the hot water supplying **62** is combined with the cooling/heating pipe **63**, a check valve V is installed at a point requiring backflow prevention to prevent the backflow of the water. In the same context, except for a method of installing the flow passage switching valve **56**, the check valve will be able to be installed at each of the outlet of the air cooling/heating pipe **54** and the outlet of the floor cooling/heating unit **51**.

Meanwhile, the water pipe **61** guides the flow of the water for performing any one of the hot water supplying and the indoor cooling/heating. The water pipe **61** includes the hot water supplying pipe **62** guiding the water discharged from the water pump **36** to the hot water supplying unit **4**, the cooling/heating pipe **63** guiding the water discharged from the water pump **36** to the cooling/heating unit **5**, a main pipe **302** connecting the water refrigerant heat exchanger and the water pump with each other, and a branch pipe **303** branched from the main pipe **302** in order to the water passing through any one of the hot water supplying unit **4** and the cooling/heating unit **5** to the intermediate heat exchanger **25**. One end of the branch pipe **303** is connected to one corresponding point of the main pipe **302** between the point where the hot water supplying pipe **62** and the cooling/heating pipe **63** are combined and the water refrigerant heat exchanger **23** and the other end of the branch pipe **303** is connected to the other point of the main pipe **303** corresponding to a discharge side of the water refrigerant heat exchanger.

At this time, the water circulation system associated with the refrigerant cycle further includes a first flow control unit **304** selectively preventing the flow of the water to the intermediate heat exchanger **25**, a second flow control unit **306** selectively preventing the flow of the water to the water refrigerant heat exchanger **23**, and a third flow control unit **305** selectively preventing the flow of water discharged from the intermediate heat exchanger **25**. The first flow control unit **304** is installed at one point of the branch pipe **303** corresponding to an inlet of the intermediate heat exchanger, the second flow control unit **306** is installed at one point of the main pipe **302** corresponding to a downstream side of the point where the branch pipe **303** is branched, and the third flow control unit **305** is installed at the other point of the branch pipe **303** corresponding to a discharge side of the intermediate heat exchanger **25**.

The first flow control unit **304** and the second flow control unit **306** serves to control a flowing amount of the water passing through the hot water supplying unit **4** and the cooling/heating unit **5** to the intermediate heat exchanger **25** and the water refrigerant heat exchanger **23**, respectively. In addition, the first flow control unit **304** and the third flow control unit **305** shields the introduction portion and the discharge portion of the intermediate heat exchanger **25**, thereby isolating water adjacent to the intermediate heat exchanger **25**.

Hereinafter, the flow of refrigerant in a first embodiment of a water circulation system associated with a refrigerant cycle according to the present invention will be described in detail with reference to the accompanying drawings.

FIG. **2** is a diagram showing the flow of refrigerant when a first embodiment of a water circulation system associated with a refrigerant cycle according to the present invention is operated in one-stage compression type, FIG. **3** is a diagram showing the flow of refrigerant when a first embodiment of a water circulation system associated with a refrigerant cycle according to the present invention is operated in two-stage compression type, and FIG. **4** is a diagram showing the flow of refrigerant when a first embodiment of a water circulation system associated with a refrigerant cycle according to the present invention is operated in one-stage and two-stage mixed compression type.

Referring to FIGS. **2** to **4**, first, the flow of the refrigerant when the water circulation system S associated with the refrigerant cycle operates in a heating mode will be described. The water circulation system S associated with the refrigerant cycle can perform a heating operation in three operation states such as the one-stage compression operation, the two-stage compression operation, and the mixed operation.

Herein, the one-stage compression operation means an operation state in which the water that flows in any one of the hot water supplying unit **4** and the cooling/heating unit **5** is heated by the first refrigerant. The two-stage compression operation means an operation state in which the water that flows in any one of the hot water supplying unit **4** and the cooling/heating unit **5** is heated by the second refrigerant. In addition, the mixed operation means an operation state in which the water that flows in any one of the hot water supplying unit **4** and the cooling/heating unit is heated by the first refrigerant and the second refrigerant at the same time.

That is, in the one-stage compression operation, the water is heated by a single refrigerant cycle performed by the first refrigerant. In addition, in the two-stage compression operation, the second refrigerant is heated by a first refrigerant cycle performed by the first refrigerant and the water is heated by a second refrigerant cycle performed by the second refrigerant. Further, in the mixed operation, the water is heated by two refrigerant cycles performed by the first refrigerant and the second refrigerant at the same time.

More specifically, referring to FIG. **2**, first, the flow of the refrigerant when the water circulation system S associated with the refrigerant cycle operates in the one-stage compression type will be described.

In the first refrigerant circulation unit, while the first refrigerant discharged from the first compressor **11** sequentially passes through the intermediate heat exchanger **25**, the first expansion unit **14**, and the outdoor heat exchanger **13**, the refrigerant cycle is performed. At this time, the first flow switch **12** maintains a state to guide the refrigerant discharged from the first compressor **11** to the intermediate heat exchanger **25**.

In addition, in the second refrigerant circulation unit, the flow of the refrigerant is stopped. That is, the operation stop of the second compressor **21** is maintained. Further, in the water circulation unit, the water discharged from the water pump **36** is introduced into any one of the hot water supplying unit **4** and the cooling/heating unit **5**. The water passing through any one of the hot water supplying unit and the cooling/heating unit **5** is introduced into the branch pipe **303**. At this time, the second flow control unit **305** maintains a closed state to prevent the flow of the water to the water refrigerant heat exchanger **23**. Further, the first flow control unit **304** and the second flow control unit **305** maintain an opened state.

In addition, the water introduced into the branch pipe **303** passes through the intermediate heat exchanger **25**. While the water passes through the intermediate heat exchanger **25**, the water is heated by exchange the heat with the first refrigerant. The water passing through the intermediate heat exchanger **25** is again introduced into the water pump **36** through the water collection tank **34**.

Next, referring to FIG. **3**, first, the flow of the refrigerant when the water circulation system S associated with the refrigerant cycle operates in the two-stage compression type will be described.

In the first refrigerant circulation unit, the flow of the first refrigerant is the same as the case where the water circulation system S associated with the refrigerant cycle operates in the one-stage compression type.

In addition, in the second refrigerant circulation unit, the second refrigerant discharged from the second compressor **21** is introduced into the water refrigerant heat exchanger **23**. While the second refrigerant introduced into the water refrigerant heat exchanger **23** passes through the water refrigerant heat exchanger **23**, the second refrigerant emits the heat to the water. In addition, the second refrigerant passing through the water refrigerant heat exchanger **23** is expanded while passing through the second expansion unit **24** and thereafter is introduced into the intermediate heat exchanger **25**. While the second refrigerant passes through the intermediate heat exchanger **25**, the second refrigerant absorbs the heat from the first refrigerant and thereafter, is again introduced into the second compressor **21**. At this time, the second flow switch guides the second refrigerant discharged from the second compressor **21** to the water refrigerant heat exchanger **23** and guides the refrigerant passing through the intermediate heat exchanger **25** to the second compressor **21**.

Further, in the water circulation unit, the water discharged from the water pump **36** is introduced into any one of the hot water supplying unit **4** and the cooling/heating unit **5**. The water passing through any one of the hot water supplying unit **4** and the cooling/heating unit **5** is introduced into the main pipe **302**. At this time, the first flow control unit **304** maintains the closed state to prevent the flow of the water to the intermediate heat exchanger **25**. Further, the second flow control unit **306** maintains the opened state.

In addition, the water introduced into the main pipe **302** passes through the water refrigerant heat exchanger **23**. While the water passes through the water refrigerant heat exchanger **23**, the water is heated by exchange the heat with the second refrigerant. The water passing through the water refrigerant heat exchanger **23** is again introduced into the water pump **36** through the water collection tank **34**.

In addition, referring to FIG. **4**, the flow of the refrigerant when the water circulation system S associated with the refrigerant cycle operates in the mixed compression type will be described.

In the first refrigerant circulation unit and the second refrigerant circulation unit, the flows of the first refrigerant and the second refrigerant are the same as the case where the water circulation system S associated with the refrigerant cycle operates in the two-stage compression type.

However, in the water circulation unit, the water discharged from the water pump **36** is introduced into any one of the hot water supplying unit **4** and the cooling/heating unit **5**. The water passing through any one of the hot water supplying unit **4** and the cooling/heating unit **5** is introduced into the main pipe **302** and the branch pipe **303** at the same time. At this time, both the first flow control unit **304** and the second flow control unit **306** maintain the opened state.

The water introduced into the main pipe **302** and the water introduced into the branch pipe **303** pass through the water refrigerant heat exchanger **23** and the intermediate heat exchanger **25**, respectively. While the water passes through the intermediate heat exchanger **25**, the water is heated by exchanging the heat with the first refrigerant and while the water passes through the water refrigerant heat exchanger **23**, the water is heated by exchanging the heat with the second refrigerant. That is, the water is heated by the first refrigerant and the second refrigerant at the same time.

In addition, the water passing through the water refrigerant heat exchanger **23** and the intermediate heat exchanger **25** is again introduced into the water pump **36** through the water collection tank **34**.

Next, in the case where the water circulation system S associated with the refrigerant cycle operates in the cooling mode, the first refrigerant and the second refrigerant flow in reverse order in the first refrigerant circulation unit and the second refrigerant circulation unit in comparison with the case where the system operates in the heating mode.

Hereinafter, the shape of an intermediate heat exchanger in a first embodiment of a water circulation system associated with a refrigerant cycle according to the present invention will be described in detail with reference to the accompanying drawings.

FIG. **5** is a diagram showing the shape of an intermediate heat exchanger in a first embodiment of a water circulation system associated with a refrigerant cycle according to the present invention.

Referring to FIG. **5**, the intermediate heat exchanger **25** is a plate-type heat exchanger **25** that includes three flow passages adjacent to each other where the first refrigerant, the second refrigerant, and water flow independently.

In detail, the plate-type heat exchanger **25** includes a plurality of plates **254**, **255**, and **256** that forms a plurality of flow passages **251**, **252**, and **253** where the first refrigerant, the second refrigerant, and water flow independently. One side of the plates **254**, **255**, and **256** is formed with an introduction portion **257** into which any one of the first refrigerant, the second refrigerant, and water is introduced and the other thereof is formed with a discharge portion **258** from which any one of the first refrigerant, the second refrigerant, and water is discharged. In other words, the introduction portion **257** and the discharger portion **258** communicate with the plurality of flow passages **251**, **252**, and **253**. However, each of the plurality of flow passages **251**, **252**, and **253** communicates with the introduction portion **257** and the discharge portion **258** of any one of the first refrigerant, the second refrigerant, and water so that any one of the first refrigerant, the second refrigerant, and water can flow.

At this time, the first refrigerant flows through any one flow passage **252** that is positioned between the remaining flow passages **251** and **253** among the plurality of flow passages **251**, **252**, and **253**. More specifically, the second refrigerant flows through the first flow passage **251** of the plurality of flow passages **251**, **252**, and **254**, the water flows through the third flow passage **253**, and the first refrigerant flows through the second flow passage **252** that is positioned between the first flow passage **251** and the third flow passage **253**.

Therefore, even when the water circulation system (S) associated with the refrigerant cycle is operated in any one state of the one-stage compression operation and the mixed operation, the heat exchange performance through the intermediate heat exchanger **25** can be maximized. In more detail, in the one-stage compression operation, the heat exchange of the first refrigerant and water is performed through the intermediate heat exchanger **25**, in the two-stage compression operation, the heat exchanger of the second refrigerant and water is performed through the intermediate heat exchanger **25**, and in the mixed operation, the heat exchange of the first refrigerant, the second refrigerant, and water is performed through the intermediate heat exchanger **25**. Therefore, the first refrigerant and water that flow the intermediate heat exchanger **25** can perform the heat exchanger in the adjacent state to each other regardless of the operation state of the water circulation system (S) associated with the refrigerant cycle.

Hereinafter, a control flow of a first embodiment of a water circulation system associated with a refrigerant cycle according to the present invention will be described in detail with reference to the accompanying drawings.

FIG. **6** is a control configuration diagram of the first embodiment of the water circulation system associated with the refrigerant cycle according to the present invention, FIG. **7** is a flowchart showing a control flow when the first embodiment of the water circulation system associated with the refrigerant cycle according to the present invention performs a heating operation, and FIG. **8** is a flowchart showing a control flow when the first embodiment of the water circulation system associated with the refrigerant cycle according to the present invention performs a defrosting operation.

Referring to FIG. **6**, the water circulation system (S) associated with the refrigerant cycle includes an outdoor temperature sensor **72** that senses the temperature of outdoor air, a target temperature sensor **73** that senses the temperature of a target to be operated by the water circulation system (S) associated with the refrigerant cycle, and a control unit **75** that controls the first flow controller **304** and the second flow controller **306** based on the outdoor air temperature and the target temperature. The outdoor temperature sensor **72**, the target temperature sensor **73**, the first flow control unit **304**, the second flow control unit **306**, and the control unit **75** are electrically connected to each other so that they can transmit and receive signals to and from each other.

The target to be operated by the water circulation system (S) associated with the refrigerant cycle means a target to be controlled for the cooling and heating and hot water supplying. For example, the target to be operated may be an indoor temperature that means the temperature of indoor air, a discharge temperature that means a temperature of water discharged from the intermediator **2**, an introduction temperature that means the temperature of water introduced into the intermediator **2**, etc.

Referring to FIG. **7**, when the heating operation of the water circulation system (S) associated with the refrigerant cycle starts, the outdoor temperature that means the temperature of the outdoor air and the target temperature that means the target temperature to be operated are sensed (S**11**).

When the outdoor temperature is a first reference temperature or more and the target temperature is below a second reference temperature (S**12**), the first flow control unit **304** is opened and the second flow control unit **306** is closed (S**13**). However, when the outdoor temperature is a first reference temperature or more and the target temperature is below a second reference temperature (S**12**), the first flow control unit **304** is opened and the second flow control unit **306** is closed (S**14**).

The case where the first flow control unit **304** is opened and the second flow control unit **306** is closed corresponds to the one-stage compression operation and the case where the first flow control unit **304** is closed and the second flow control unit **306** is opened corresponds to the two-stage compression operation. Therefore, the case where the outdoor temperature is the first reference temperature or more and the target temperature is below the second reference temperature may be referred to as the one-stage compression condition and the case other than the case where the outdoor temperature is the first reference temperature or more and the target temperature is below the second reference temperature may be referred to as the two-stage compression condition.

At this time, the first reference temperature and the second reference temperature mean the outdoor temperature and the target temperature corresponding to the operation conditions where the efficiency of the water circulation system (S) associated with the refrigerant cycle in the case of the one-stage compression operation and the efficiency of the water circulation system (S) associated with the refrigerant cycle of the two-stage compression operation are identical.

In more detail, as the outdoor temperature is high and the target temperature is low, the efficiency of the case of the one-stage compression operation is higher than the efficiency of the case of the two-stage compression operation. On the other hand, as the outdoor temperature is low and the target temperature is high, the efficiency of the case of the two-stage compression operation is higher than the efficiency of the case of the one-stage compression operation. Therefore, while the outdoor temperature and the target temperature are changed, there may be the outdoor temperature and the target temperature where the efficiency of the case of the two-stage compression operation is the same level of the efficiency of the case of the one-stage compression operation. Therefore, according to the control flow, the operation state of the water circulation system (S) associated with the refrigerant cycle is varied in the direction where the operation efficiency is higher according to the outdoor temperature and the target temperature.

Meanwhile, if the operation stop signal of the water circulation system (S) associated with the refrigerant cycle is not input, the process is repeatedly performed.

According to the water circulation system (S) associated with the refrigerant cycle, the operation efficiency can be maximized. In more detail, when the efficiency of the one-stage compression is operated is higher the efficiency of the case of the two-stage compression operation based on the first reference temperature and the second reference temperature as a reference, the water circulation system (S) associated with the refrigerant cycle is operated in the one-stage compression type and when the efficiency of the two-stage compression operation is higher than the efficiency of the one-stage compression operation, the water circulation system (S) associated with the refrigerant cycle is operated in the two-stage compression type. Therefore, the water circulation system (S) associated with the refrigerant cycle may be operated in the direction where the operation efficiency can be maximized according to the outdoor temperature and the target temperature.

Describing the defrosting operation with reference to FIG. **8**, the water circulation system associated with the refrigerant cycle is first operated in a mode set by the user's selection (S**21**). However, the defrosting operation to be described below is high likely to be need in the environment where the external temperature of the heat exchanger serving as an evaporator is below zero temperature, that is, the winter where the heating operation is mainly performed. Therefore, the water circulation system associated with the refrigerant cycle that performs the defrosting operation during the heating operation as described above will be described.

While the water circulation system associated with the refrigerant cycle performs the heating operation, it is determined whether the defrosting operation condition is satisfied (S**22**). Whether the defrosting operation condition is operated may be determined by comparing the pipe outlet temperature of the outdoor heat exchanger **13** with the outdoor temperature. However, in the present embodiment, the determination on whether the defrosting operation condition is satisfied may be performed in various methods and therefore, it is to be noted that the present embodiment can use a method for determining whether the defrosting operation is satisfied, without limitation.

When the defrosting operation condition is satisfied, the first refrigerant circulation unit is operated in a defrosting mode and the second refrigerant circulation unit maintains the operation mode (heating mode) (S**23**).

When the first refrigerant circulation unit is operated in the defrosting mode, the intermediate heat exchanger **25** serves as the evaporator in each refrigerant circulation units **1** and **2** and the outdoor heat exchanger **25** serves as a condenser. Therefore, while the first refrigerant circulation unit is operated in the defrosting mode, the defrosting of the outdoor heat exchanger **13** is performed by the high-temperature refrigerant that flows to the outdoor heat exchanger **13**.

At this time, when the intermediate heat exchanger **25** serves as the evaporator of each refrigerant circulation unit, the evaporation pressure of each refrigerant circulation units **1** and **2** becomes small, such that there is a risk of the performance degradation of each refrigerant circulation units **1** and **2** and the damage of each compressor.

Therefore, in the present embodiment, in order to prevent the reduction of the evaporation pressure in the intermediate heat exchanger **25**, while the first refrigerant circulation unit is operated in the defrosting mode, the first flow control unit **304** and the third flow control unit **305** are closed (S**24**). The flow of water stops in the branch pipe **303** and the hot water is heat exchanged with the first refrigerant inside the branch pipe **303**. The first refrigerant heat exchanged with the hot water and the second refrigerant is heat exchanged, such that the temperature of each refrigerant is increased, thereby making it possible to minimize the reduction of the evaporation pressure of each refrigerant circulation unit.

Next, while the first refrigerant circulation unit is operated in the defrosting mode, it is determined whether the defrosting is ended (S**25**).

If it is determined whether the defrosting is ended, the closed first flow control unit **304** and third control unit **305** are opened (S**26**). The first refrigerant circulation unit is operated in a previous mode (S**27**). That is, the first refrigerant circulation unit is operated in a heating mode.

According to the above-mentioned embodiment, while the first refrigerant circulation unit is operated in the defrosting mode, the second refrigerant circulation unit is continuously operated in the heating mode, such that the indoor heating or the hot water supplying can be performed. In addition, the hot water of the branch pipe **303** is heat exchanged with the first refrigerant that flows to the intermediate heat exchanger **25** to increase the temperature of the first refrigerant, such that the evaporation pressure of each refrigerant circulation unit is minimized, thereby making it possible to minimize the performance degradation of each refrigerant circulation unit.

Hereinafter, a second embodiment of a water circulation system associated with a refrigerant cycle according to the present invention will be described in detail with reference to the accompanying drawings. The second embodiment is different from the first embodiment in that the intermediate heat exchanger is formed in a triple-pipe, the mixed operation is performed during the reference time in the case of the two-stage compression condition, and the first flow control unit **304** and the third flow control unit **305** are opened during the defrosting operation.

FIG. **9** is a diagram showing a shape of the intermediate heat exchanger of the second embodiment of the water circulation system associated with the refrigerant cycle according to the present invention, FIG. **10** is a flowchart showing a control flow when the second embodiment of the water circulation system associated with the refrigerant cycle according to the present invention performs a heating operation, and FIG. **11** is a flowchart showing a control flow when the second embodiment of the water circulation system associated with the refrigerant cycle according to the present invention performs a defrosting operation.

Referring to FIG. **9**, in the second embodiment, the intermediate heat exchanger **85** is a triple-pipe shape in which three independent flow passages are formed by three pipes having a concentric axis and different diameters. Specifically, the intermediate heat exchanger **85** includes a first flow passage **851** positioned at the innermost side, a second flow passage **852** positioned outside of the first flow passage **851**, and a third flow passage **853** positioned outside of the second flow passage **852**. The first flow passage **851** is in communication with a second refrigerant pipe **26** through which second refrigerant flows, the second flow passage **852** is in communication with a first refrigerant pipe **15** through which first refrigerant flows, and the third flow passage **853** is in communication with a water pipe **303** through which water flows. That is, the second refrigerant flows through the first flow passage **851**, the first refrigerant flows through the second flow passage **852**, and the water flows through the third flow passage **853**.

On the other hand, the intermediate heat exchanger **85** includes a plurality of heat exchanging units **86** and **87** that are removably connected with each other. The heat exchanging units **86** and **87** each include three flow passages **851**, **852**, and **853**. Each of the heat exchange units **86** and **87** is connected to the first refrigerant pipe **15**, the second refrigerant pipe **26**, and the water pipe **303**.

At this time, a plurality of introduction portions **881**, **883**, and **885** and refrigerant discharge portions **882**, **884**, and **886** that are selectively connected to each of the plurality of heat exchanging units **86** and **87** are provided in the first refrigerant pipe **15**, the second refrigerant pipe **26**, and the water pipe **303**. More specifically, the plurality of introduction portions **881**, **883**, and **885** and refrigerant discharge portions **882**, **884**, and **886** include a first refrigerant introduction portion **881** and a first refrigerant discharge portion **882** for introducing and discharging the first refrigerant, a second refrigerant introduction portion **883** and a second refrigerant discharge portion **884** for introducing and discharging the second refrigerant, and a water introduction portion **885** and a water discharge portion **886** for introducing and discharging the water.

In addition, each of the plurality of introduction portion **881**, **883**, and **885** and discharge portions **882**, **884**, and **886** includes a plurality of flow preventing portions **857** for selectively shielding the plurality of introduction portion **881**, **883**, and **885** and discharge portions **882**, **884**, and **886**. The plurality of flow preventing portions **857** selectively prevents the flow of at least one of the first refrigerant, the second refrigerant, and the water through the plurality of introduction portion **881**, **883**, and **885** and discharge portions **882**, **884**, and **886**.

Meanwhile, the heat exchange capacity of the intermediate heat exchanger **85** may be varied depending on the number of the heat exchanging units **86** and **87** connected to the first refrigerant pipe **15**, the second refrigerant pipe **26**, and the water pipe **303**. Further, as the flow of the refrigerant to the plurality of heat exchanging units **86** and **87** is selectively prevented by the plurality of flow preventing portions **857**, the heat exchange capacity of the intermediate heat exchanger **85** may be varied.

More specifically, since the heat exchanging units **86** and **87** are selectively and removably connected to the introduction portions **881**, **883**, and **885** and the discharge portions **882**, **884**, and **886**, the heat exchanging unit **86** and **87** may be connected to the introduction portions **881**, **883**, and **885** and the discharge portions **882**, **884**, and **886** by changing the number of connected portions as necessary.

Further, by preventing the flow of the first refrigerant, the second refrigerant, and the water to the heat exchanging units **86** and **87** by means of the flow preventing portion **857** even in the state where the heat exchanging units **86** an **87** are connected to the introduction portions **881**, **883**, and **885** and the discharge portions **882**, **884**, and **886**, the number of the heat exchanging units **86** and **87** substantially used for exchanging the heat may be varied. By this method, the entire heat exchanging capacity of the intermediate heat exchanger **85** may be varied. By this method, the entire heat exchanging capacity of the intermediate heat exchanger **85** may be varied.

Meanwhile, the type in which the first refrigerant, the second refrigerant, and the water flows through three flow passages **851**, **852**, and **853** has various numbers of cases. That is, the first refrigerant flows through any one of three flow passages **851**, **852**, and **853**, the second refrigerant flows through another of three flow passages **851**, **852**, and **853**, and the water flows through the other one of three flow passages **851**, **852**, and **853**. Accordingly, the first refrigerant, the second refrigerant, and the water may flow through three flow passages **851**, **852**, and **853** in six types.

Further, the flow directions of fluids that flow through adjacent flow passages among the fluids that flow through three flow passages **851**, **852**, and **853** are opposite to each other. At this time, the fluids include the first refrigerant, the second refrigerant, and the water. That is, two fluids that flow adjacent to each other among the first refrigerant, the second refrigerant, and the water flow opposite to each other in the intermediate heat exchanger **85**. Accordingly, the heat exchange efficiency of the intermediate heat exchanger **85** can further be improved.

Referring to FIG. **10**, in the present embodiment, the mixed operation is performed during the reference time in the case corresponding to the two-stage compression condition.

In detail, when the operation of the water circulation system (S) associated with the refrigerant cycle starts, the outdoor temperature and the target temperature are sensed (S**31**). In the case where the outdoor temperature and the target temperature correspond to the one-stage compression condition (S**32**), the first flow control unit **304** is opened and the second flow control unit **306** is closed, such that the one-stage compression operation starts (S**33**).

However, when the outdoor temperature and the target temperature does not correspond to the one-stage compression condition, that is, when they correspond to the two-stage compression condition (S**32**), both the first flow control unit **304** and the second flow control unit **306** are opened, such that the mixed operation starts (S**34**).

After the mixed operation starts and the reference time elapses (S**35**), the outdoor temperature and the target temperature are sensed (S**36**). When the outdoor temperature and the target temperature still correspond to the two-stage compression condition (S**37**), the first flow control unit **304** is closed, such that the two-stage compression operation starts (S**38**). However, when the outdoor temperature and the target temperature are changed in the one-stage compression condition (S**37**), the outdoor temperature and the target temperature are sensed again (S**31**). At this time, the reference time means the time required from the time when the first flow control unit **304** and the second flow control unit **306** are switched to the time when the outdoor temperature and the target temperature are stabilized.

If the operation stop signal of the water circulation system (S) associated with the refrigerant cycle is not input, the process is repeatedly performed.

According to the present embodiment, the efficiency of the water circulation system (S) associated with the refrigerant cycle can be optionally maintained according to the change in the outdoor temperature and the target temperature.

In more detail, even when the outdoor temperature and the target temperature correspond to the two-stage compression condition, the efficiency of the mixed operation may be higher than that of the two-stage compression operation. For example, when the outdoor temperature and the target temperature have a value approximating to the first reference temperature and the second reference temperature, the efficiency of the mixed operation may be higher than that of the two-stage compression.

However, in the present embodiment, when the outdoor temperature and the target temperature deviates from the one-stage compression condition, the mixed operation is primarily performed during the reference time and despite of the mixed operation, when they does not enter the one-stage compression condition, the two-stage compression operation is finally performed. Therefore, the efficiency of the water circulation system (S) associated with the refrigerant cycle can be optionally maintained according to the outdoor temperature and the target temperature.

Describing the defrosting operation with reference to FIG. **11**, the water circulation system associated with the refrigerant cycle is first operated in a mode set by the user's selection (S**41**). However, the case where the present embodiment performs the defrosting operation during the heating operation will be described below.

The first flow control unit **304** and the third flow control unit **305** of the branch pipe **303** maintain the closed state while each of the refrigerant circulation units **1** and **2** performs the heating operation. Further, the second flow control unit **306** maintains the opened state. Therefore, the water passing through the water circulation unit is heat exchanged with the second refrigerant while passing through the water refrigerant heat exchanger **23**.

When the second refrigerant circulation unit is operated in the heating mode, the temperature of water flowing to the water pipe **61** is continuously increased. In particular, the temperature of water flowing to the main pipe **302** adjacent to the water refrigerant heat exchanger **23** is continuously increased.

It is determined whether the defrosting operation condition is satisfied while the water circulation system is operated in the set mode (S**42**). When the defrosting operation condition is satisfied, the first refrigerant circulation unit is operated in the defrosting mode and the second refrigerant circulation unit maintains the original operation mode (heating mode).

When the first refrigerant circulation unit is operated in the defrosting mode, the first flow control unit **304** and the third flow control unit **305** are opened (S**14**). When the first flow control unit **304** and the third flow control unit **305** are opened, at least a part of the hot water flowing to the water circulation unit is heat exchanged with the first refrigerant while flowing to the intermediate heat exchanger **25**. The first refrigerant heat exchanged with the hot water and the second refrigerant is heat exchanged, such that the temperature of each refrigerant is increased, thereby making it possible to minimize the reduction of the evaporation pressure of each refrigerant circulation unit.

Next, while the first refrigerant circulation unit is operated in the defrosting mode, it is determined whether the defrosting is ended (S**45**). If it is determined whether the defrosting is ended, the closed first flow control unit **304** and third control unit **305** are closed (S**46**). The first refrigerant circulation unit is operated in a previous mode (S**47**). That is, the first refrigerant circulation unit will be operated in the heating mode.

In addition to the above-mentioned two embodiments, the following embodiment will be described.

When the first refrigerant circulation unit is operated in the defrosting mode while each of the refrigerant circulation units **1** and **2** is operated in the heating mode, if the first flow control unit **304** and the third flow control unit **305** are in the closed state, the first flow control unit **204** and the third flow control unit **305** are opened and if the defrosting is ended, the first flow control unit **304** and the third flow control unit **305** can be closed. On the other hand, if the first flow control unit **304** and the third flow control unit **305** are in the opened state, the first flow control unit **304** and the third flow control unit **305** may be maintained in the opened state.

Hereinafter, a fourth embodiment of a water circulation system associated with a refrigerant cycle according to the present invention will be described in detail with reference to the accompanying drawings. The fourth embodiment is different from the first embodiment in that the flowing amount of water to the intermediate heat exchanger and the water refrigerant heat exchanger is controlled according to the outdoor temperature and the target temperature and when the defrosting operation is performed, it is opposite to the case of the heating operation in terms of the refrigerant flowing of the first refrigerant circulation unit and the second circulation unit.

FIG. **12** is a flowchart showing a control flow when a third embodiment of a water circulation system associated with a refrigerant cycle according to the present invention performs a heating operation and FIG. **13** is a flowchart showing a mixed operation process based on an outdoor temperature in the third embodiment of the water circulation system associated with the refrigerant cycle according to the present invention. FIG. **14** is a flowchart showing a mixed operation process based on a target temperature in the third embodiment of the water circulation system associated with the refrigerant cycle according to the present invention and FIG. **15** is a flowchart showing a control flow when the third embodiment of the water circulation system associated with the refrigerant cycle according to the present invention performs a defrosting operation.

Referring to FIGS. **12** to **14**, in the present embodiment, when the water circulation system (S) associated with the refrigerant cycle performs the mixed operation, the flowing amount of water to the intermediate heat exchanger **25** and the water refrigerant heat exchanger **23** is controlled according to the outdoor temperature and the target temperature.

In detail, when the operation of the water circulation system (S) associated with the refrigerant cycle starts, the outdoor temperature and the target temperature are sensed (S**51**). In the case where the outdoor temperature and the target temperature correspond to the one-stage compression condition (S**52**), the first flow control unit **304** is opened and the second flow control unit **306** is closed, such that the one-stage compression operation starts (S**53**).

However, the case other than the case where the outdoor temperature and the target temperature corresponds to the one-stage compression condition (S**52**), it determines whether the outdoor temperature is below the first reference temperature and the target temperature is the second reference temperature or more (S**54**). However, when the outdoor temperature is below the first reference temperature and the target temperature is the second reference temperature or more (S**54**), the first flow control unit **304** is closed and the second flow control unit **306** is opened (S**55**).

Herein, the state where the first flow control unit **304** is closed and the second flow control unit **306** is opened means the two-stage compression operation. Therefore, the case where the outdoor temperature is below the first reference temperature and the target temperature is the second reference temperature or more may be referred to the two-stage compression condition.

However, the case where the outdoor temperature and the target temperature do not correspond to the two-stage compression condition (S**54**), it determines whether the outdoor temperature is below the first reference temperature (S**56**) and the target temperature is the second reference temperature or more (S**58**).

The case where the outdoor temperature and the target temperature do not correspond to the two-stage compression condition (S**54**) and the outdoor temperature is below the first reference temperature (S**56**) or the target temperature is the second reference temperature or more (S**58**) may be referred to the mixed condition.

The case where the outdoor temperature and the target temperature do correspond to the mixed condition (S**56** and S**58**), the mixed operation starts (S**57** and S**59**). The mixed operation includes the outdoor temperature reference mixed operation and the target temperature reference mixed operation.

In more detail, the case where the outdoor temperature and the target temperature do not correspond to the two-stage compression condition and the outdoor temperature is below the first reference temperature may be referred to as the outdoor temperature reference mixed condition and the case where the outdoor temperature and the target temperature do not correspond to the two-stage compression condition and the target temperature is the second reference temperature or more may be referred to as the target temperature reference mixed condition. When the outdoor temperature and the target temperature corresponds to the outdoor temperature reference mixed condition (S**56**), the outdoor temperature reference mixed operation is performed (S**57**) and when they corresponds to the target temperature reference mixed condition (S**58**), the target temperature reference mixed operation is performed (S**59**).

Referring to FIG. **11**, when the outdoor temperature reference mixed operation is performed, it determines whether the outdoor temperature is below the third reference temperature (S**571**). When the outdoor temperature is below the third reference temperature, the two-stage compression operation is performed (S**572**).

However, when the outdoor temperature corresponds to the third reference temperature or more (S**571**), the opening degrees of the first flow control unit **304** and the second flow control unit **306** are controlled so that the ratio of the difference of the first reference temperature and the outdoor temperature with respect to the difference of the first reference temperature and the third reference temperature is the same as the ratio of the opening degree of the second flow control unit **306** with respect to the opening degree of the first flow control unit **304** (S**573**).

At this time, the third reference temperature means the outdoor temperature that makes the efficiency of the mixed operation and the efficiency of the two-stage compression operation same. In other words, when the outdoor temperature is higher than the third reference temperature, the efficiency of the mixed operation is higher than that of the two-stage compression operation. To the contrary, when the outdoor temperature is lower than the third reference temperature, the efficiency of the two-stage compression operation is higher than that of the mixed operation. The third reference temperature corresponds to a temperature value smaller than the first reference temperature.

Referring to FIG. **12**, when the target temperature reference mixed operation is performed, it determines whether the target temperature corresponds to a fourth reference temperature or more (S**591**). When the outdoor temperature corresponds to the fourth reference temperature or more, the two-stage compression operation is performed (S**592**).

However, when the outdoor temperature is below the fourth reference temperature (S**591**), the opening degrees of the first flow control unit **304** and the second flow control unit **306** are controlled so that the ratio of the difference of the first reference temperature and the outdoor temperature with respect to the difference of the fourth reference temperature and the second reference temperature is the same as the ratio of the opening degree of the second flow control unit **306** with respect to the opening degree of the second flow control unit **306** (S**593**).

At this time, the fourth reference temperature means the target temperature that makes the efficiency of the mixed operation and the efficiency of the two-stage compression operation same. In other words, when the target temperature is higher than the fourth reference temperature, the efficiency of the two-stage compression operation is higher than that of the mixed operation. To the contrary, when the target temperature is lower than the fourth reference temperature, the efficiency of the mixed operation is higher than that of the two-stage compression operation. The fourth reference temperature corresponds to a temperature value higher than the second reference temperature.

According to the present embodiment, the operation efficiency of the water circulation system (S) associated with the refrigerant cycle can be more optimized according to the change in the outdoor temperature and the target temperature. In detail, in the case of the mixed condition, the opening degrees of the first flow control unit **304** and the second flow control unit **306** are varied according to any one of the difference of the outdoor temperature and the third reference temperature and the difference of the target temperature and the fourth reference temperature.

In detail, in the case of the outdoor temperature reference mixed condition, as the outdoor temperature approaches to the first reference temperature, the opening degree of the first flow control unit **304** is relatively increased compared to the opening degree of the second flow control unit **306**. In other words, as the outdoor temperature approaches to the first reference temperature, the water circulation system (S) associated with the refrigerant cycle is operated in a state close to the one-stage compression operation. To the contrary, when the outdoor temperature approaches to the third reference temperature, the opening degree of the second flow control unit **306** is relatively increased compared to the opening degree of the first flow control unit **304**. In other words, as the outdoor temperature approaches to the third reference temperature, the water circulation system (S) associated with the refrigerant cycle is operated in a state close to the two-stage compression operation.

In detail, in the case of the target temperature reference mixed condition, as the target temperature approaches to the second reference temperature, the opening degree of the first flow control unit **304** is relatively increased compared to the opening degree of the second flow control unit **306**. In other words, as the target temperature approaches to the second reference temperature, the water circulation system (S) associated with the refrigerant cycle is operated in a state close to the one-stage compression operation. To the contrary, when the outdoor temperature approaches to the fourth reference temperature, the opening degree of the second flow control unit **306** is relatively increased compared to the opening degree of the first flow control unit **304**. In other words, as the outdoor temperature approaches to the fourth reference temperature, the water circulation system (S) associated with the refrigerant cycle is operated in a state close to the two-stage compression operation.

In other words, in the case of satisfying the mixed operation, the flowing amount of water to the intermediate heat exchanger **25** and the flowing amount of water to the water refrigerant heat exchanger **23** are varied to be in inverse proportion to each other.

Therefore, the water circulation system (S) associated with the refrigerant cycle can be optionally operated according to the outdoor temperature and the target temperature.

Describing the defrosting operation with reference to FIG. **15**, the water circulation system (S) associated with the refrigerant cycle is first operated in a mode set by the user's selection (S**61**). The case where the defrosting operation is performed during the heating operation will be described below.

It is determined whether the defrosting operation condition is satisfied while the water circulation system (S) is operated in the set mode (S**62**). If the defrosting operation condition is satisfied, both the first refrigerant circulation unit and the second refrigerant circulation unit are operated in the defrosting mode (S**63**).

In the present embodiment, the case where the first refrigerant circulation unit is operated in the defrosting mode means the case where the first refrigerant circulation unit is operated in the cooling mode.

The case where the second refrigerant circulation unit is operated in the defrosting mode means the following two cases. The first case means the case where the operation of the second refrigerant circulation unit stops and the second case means the case where the second compressor **21** is operated at a lower frequency than the operation frequency of the second compressor in the previous mode while the second refrigerant circulation unit is basically operated in the heating mode.

In the first case, when the second refrigerant circulation unit is operated in the heating mode, if the first flow control unit **304** and the third flow control unit **305** are opened, the first flow control unit **304** and the third flow control unit **305** are closed. As described in the first embodiment, when the first flow control unit **304** and the third flow control unit **305** are closed, the hot water inside the branch pipe **303** and the first refrigerant are heat exchanged with each other.

In the second case, when the second refrigerant circulation unit is operated in the heating mode, the first flow control unit **304** and the third flow control unit **305** may be the closed state or the opened stated and the opening or closing of the first flow control unit **304** and the third flow control unit **305** can be controlled in the method described in the previous embodiments when the first refrigerant circulation units **1** and **2** are operated in the defrosting mode.

According to the two cases, it can be easily appreciated that the reduction of the evaporation pressure of each refrigerant circulation units **1** and **2** can be minimized. Next, while each refrigerant circulation unit is operated in the defrosting mode, it is determined whether the defrosting is ended (S**64**). When the defrosting is ended, each refrigerant circulation unit is operated in the previous mode (S**65**). That is, each refrigerant circulation unit will be operated in the heating mode.

Hereinafter, a fifth embodiment of a water circulation system associated with a refrigerant cycle according to the present invention will be described in detail with reference to the accompanying drawings. The fifth embodiment is different from the first embodiment in that the first flow control unit and the second flow control unit are controlled according to the operation or not of the second compressor and the flowing amount of water flowing to the water circulation unit is reduced during the defrosting operation.

FIG. **16** is a control configuration diagram of a fourth embodiment of a water circulation system associated with a refrigerant cycle according to the present invention, FIG. **17** is a flowchart showing a control flow when the fourth embodiment of the water circulation system associated with the refrigerant cycle according to the present invention performs a heating operation, and FIG. **18** is a flowchart showing a control flow when the fourth embodiment of the water circulation system associated with the refrigerant cycle according to the present invention performs a defrosting operation.

Referring to FIGS. **16** and **17**, in the present embodiment, the first flow control unit **304** and the second flow control unit **306** are controlled according to the operation or not of the second compressor **21**. In other words, the present embodiment includes a second compressor operation sensing unit **91** that senses the operation or not of the second compressor **21** and transmits it to the control unit **95**.

In more detail, when the operation of the water circulation system (S) associated with the refrigerant cycle starts, the operation of the second operation **21** is sensed (S**71**). At this time, as a method of sensing the operation of the second compressor **21**, there may be a rotation sensor that senses the rotation or not of the compressor or a method for sensing the current or voltage supplied to the compressor, etc.

When the operation of the second compressor **21** stops (S**72**), the first flow control unit **304** is opened and the second flow control unit **306** is closed (S**73**). In other words, when it is sensed as the operation of the second compressor stops, the one-stage compression operation is performed (S**73**).

As the case where the operation of the second compressor **21** stops, there may be various situations such as the malfunction or fault of the second compressor **21**, etc. Since the flowing of the second refrigerant stops in the state where the second compressor **21** stops, the water introduced into the water refrigerant heat exchanger **23** passes therethrough without the change in state. In this case, the water continuously flows to the water refrigerant heat exchanger **23**, which may have a bad effect on the operation for the indoor cooling and heating and the hot water supplying.

In the present embodiment, when the second compressor **21** stops, the flowing of water to the water refrigerant heat exchanger **23** is prevented. Therefore, even though a sudden situation such as the case of the failure of the second compressor **21** occurs, the indoor cooling and heating or the hot water supplying operations can be stably continued. Describing the defrosting operation of the embodiment with reference to FIG. **18**, the water circulation system (S) associated with the refrigerant cycle is first operated in a mode set by the user's selection (S**81**).

It is determined whether the defrosting operation condition is satisfied while the water circulation system (S) is operated in the set mode (S**82**). When the defrosting operation condition is satisfied, the first refrigerant circulation unit is operated in the defrosting mode and the second refrigerant circulation unit maintains the original operation mode (heating mode) (S**83**).

When the first refrigerant circulation unit is operated in the defrosting mode, the intermediate heat exchanger **25** serves as the evaporator for each refrigerant circulation units **1** and **2**.

At this time, the intermediated heat exchanger serves as the evaporator for each refrigerant circulation unit, such that the evaporation pressure of each refrigerant circulation unit becomes small, thereby makes the condensing temperature of the second heat exchanger **23** low. When the condensing temperature of the second heat exchanger **23** is low, the temperature of water stored in the water collection tank **34** is low.

When the temperature of water stored in the water collection tank **34** is low, the temperature of water flowing to the cooling and heating pipe **63** of the cooling and heating unit **5** is low, such that the indoor temperature may be low. Therefore, in the present embodiment, when the first refrigerant circulation unit is operated in the defrosting modes, the operation of the water pump **36** is changed so that the amount of water flowing to the water circulation unit is more reduced than when the first refrigerant circulation unit is operated in the heating mode (S**84**). In this case, the amount of water flowing to the cooling and heating pipe **63** of the cooling and heating unit **5** is reduced, thereby making it possible to minimize the reduction of the indoor temperature.

Next, while the first refrigerant circulation unit is operated in the defrosting mode, it is determined whether the defrosting is ended (S**85**). When the defrosting is ended, the water pump **36** is operated in the previous state, such that the flowing amount of the cooling and heating pipe **63** is returned to the previous state (S**86**). The first refrigerant circulation unit is operated in the previous mode (S**87**).

What is claimed is:

1. A water circulation system associated with a refrigerant cycle comprising:

a first refrigerant circulation unit where a first refrigerant exchanging heat with outdoor air flows to perform the refrigerant cycle;

a second refrigerant circulation unit where a second refrigerant exchanging heat with the first refrigerant flows to perform the refrigerant cycle;

a water circulation unit where water for at least one of indoor heating/cooling and hot water supplying flows;

a first water refrigerant heat exchanger that performs the heat exchange between the first refrigerant and water;

a second water refrigerant heat exchanger that performs the heat exchange between the second refrigerant and water;

a first flow control unit that selectively prevents the flow of water to the first water refrigerant heat exchanger; and

a second flow control unit that selectively prevents the flow of water to the second water refrigerant heat exchanger.

2. The water circulation system associated with the refrigerant cycle according to claim **1**, wherein the opening degrees of the first flow control unit and the second flow control unit are controlled according to operation conditions.

3. The water circulation system associated with the refrigerant cycle according to claim **2**, wherein the operation condition includes:

a one-stage compression condition where an outdoor temperature is a first reference temperature or more and a target temperature is below a second reference temperature; and

a two-stage compression condition corresponding to at least one of the case where the outdoor temperature is below the first reference temperature and the case where the target temperature is the second reference temperature or more.

4. The water circulation system associated with the refrigerant cycle according to claim **3**, wherein when the one-stage compression condition is satisfied, the first flow control unit is opened and the second flow control unit is closed.

5. The water circulation system associated with the refrigerant cycle according to claim **3**, wherein when satisfying the two-stage compression condition, the first flow control unit is closed and the second flow control unit is opened.

6. The water circulation system associated with the refrigerant cycle according to claim **3**, wherein when satisfying the two-stage compression condition, both the first flow control unit and the second flow control unit are opened, and

when satisfying the two-stage compression condition even after the reference time elapses from the time when both the first flow control unit and the second flow control unit are opened, the first flow control unit is closed.

7. The water circulation system associated with the refrigerant cycle according to claim **2**, wherein the operation condition includes a mixed condition corresponding to only any one of the case where the outdoor temperature is below the first reference temperature and the case where the target temperature is the second reference temperature or more.

8. The water circulation system associated with the refrigerant cycle according to claim **7**, wherein when satisfying the mixed condition, both the first flow control unit and the second flow control unit are opened.

9. The water circulation system associated with the refrigerant cycle according to claim **7**, wherein when satisfying the mixed condition, the flow amount of water to the first water refrigerant heat exchanger and the second water refrigerant heat exchanger is varied to be in inverse proportion to each other by the first flow control unit and the second flow control unit.

10. The water circulation system associated with the refrigerant cycle according to claim **7**, wherein the opening degrees of the first flow control unit and the second flow control unit are controlled so that the ratio of the opening degrees of the first flow control unit and the second flow control unit is proportional to the difference between the outdoor temperature and the first reference temperature when satisfying the mixed condition.

11. The water circulation system associated with the refrigerant cycle according to claim **1**, wherein the second refrigerant circulation unit includes a second compressor that compresses the second refrigerant, and

when the operation of the second compressor stops, the flow of the second refrigerant to the second water refrigerant heat exchanger is prevented by the second flow control unit.

12. The water circulation system associated with the refrigerant cycle according to claim **1**, further comprising:

an outdoor temperature sensor that senses the temperature of the outdoor air;

a target temperature sensor that senses the temperature of the target controlled for at least one of the indoor cooling and heating and hot water supplying; and

a compressor operation sensor that senses whether the compressor is operated.

13. The water circulation system associated with the refrigerant cycle according to claim **1**, wherein the first water refrigerant heat exchanger includes three flow passages that independently flows the first refrigerant, the second refrigerant, and water so that the first refrigerant, the second refrigerant, and water are heat-exchanged independently.

14. The water circulation system associated with the refrigerant cycle according to claim **13**, further comprising:

an outdoor heat exchanger that performs the heat exchange between the outdoor air and the first refrigerant;

a main pipe that connects to the water circulation unit to the second water refrigerant heat exchanger; and

a branch pipe that connects the water circulation unit to the first water refrigerant heat exchanger,

wherein when the defrosting operation condition for defrosting the outdoor heat exchanger is satisfied during the healing operation, the refrigerant flow direction of the first refrigerant circulation unit is switched and the flow of water through the branch pipe is prevented.

15. The water circulation system associated with the refrigerant cycle according to claim **13**, further comprising:

an outdoor heat exchanger that performs the heat exchange between the outdoor air and the first refrigerant;

a water pipe that guides water flowing the water circulation unit,

wherein when the defrosting operation condition for defrosting the outdoor heat exchanger is satisfied during the heating operation, the refrigerant flow direction of the first refrigerant circulation unit is switched and the flow of water through the water pipe is prevented.

16. A water circulation system associated with a refrigerant cycle comprising:

a first refrigerant circulation unit where a first refrigerant exchanging heat with outdoor air flows to perform the refrigerant cycle;

a second refrigerant circulation unit where a second refrigerant exchanging heat with the first refrigerant flows to perform the refrigerant cycle;

a water circulation unit where water for at least one of indoor heating/cooling and hot water supplying flows;

a first water refrigerant heat exchanger that performs the heat exchange between the first refrigerant and water: and

a second water refrigerant heat exchanger that performs the heat exchange between the second refrigerant and water;

wherein at least one of the flow of water to the first water refrigerant heat exchanger and the flow of water to the second water refrigerant heat exchanger is selectively prevented according to operation conditions.

17. The water circulation system associated with the refrigerant cycle according to claim **16**, wherein the operation condition includes:

a one-stage compression condition where an outdoor temperature is a first reference temperature or more and a target temperature is below a second reference temperature; and

a two-stage compression condition corresponding to at least one of the case where the outdoor temperature is below a first reference temperature and the case where the target temperature is a second reference temperature or more; and

a mixed condition corresponding to only any one of the case where the outdoor temperature is below the first reference temperature and the case where the target temperature is the second reference temperature or more.

18. The water circulation system associated with the refrigerant cycle according to claim **17**, wherein when satisfying the one-stage compression condition, water flows through the first water refrigerant heat exchanger and the flow of water to the second water refrigerant heat exchanger is prevented.

19. The water circulation system associated with the refrigerant cycle according to claim **17**, wherein when satisfying the two-stage compression condition, the flow of water to the first water refrigerant heat exchanger is prevented and water flows through the second water refrigerant heat exchanger.

20. The water circulation system associated with the refrigerant cycle according to claim **17**, wherein when satisfying the mixed condition, water simultaneously flows to the first water refrigerant heat exchanger and the second water refrigerant heat exchanger.

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